ELECTRICAL REVIEW
AND
INDUSTRIAL ENGINEER

Volume 80 Chicago, March, 1922 *Number 3*

That Job of

Hiring and Firing

WHEN I stand on the balcony of our shop, I can usually tell by the way the men stand at their work whether they are interested in it or thinking of something else. Whenever I see a man stalking about like a first lieutenant apparently admiring himself or parading his superior knowledge of what he is supposed to be doing, I just feel a deep sense of pity for him and when the time comes we have a little heart to heart talk. The statement that Mr. Housley makes in this issue that "a man may be preached to, sworn at or laughed at, with less benefit than if nothing at all had been said," is all too true. I've done a little of all three and the effect is just the same.

But once you can get a man interested in his job and help him to see the real fun that he can get out of hard work well done, then the trouble of supervision vanishes. If a man's job is just work to him he's in wrong, for any human who cannot feel that the joy of his job is half his pay, has the wrong job. You remember that saying, "a mule on a Kentucky race track would be a comedy, but a thoroughbred hitched to a plow is a tragedy"—and it's about so among men.

The hardest job I have to do is to fire one man and hire another. In the first instance, if I make a mistake in the firing act so as to break the man's spirit nothing short of an inhuman act is committed. And instead of telling him I don't need him any longer, it would be more truthful to say: "Old man, I confess my lack of imagination and judgment in not being able to find a way to use your ability; therefore, I am letting you go." On the other hand, if a mistake is made in hiring, there is always the chance of correcting it by shifting the man until a place is found where he fits.

In these days when men need work and plants need brains as well as brawn, and are ready to pay for it, hiring and firing is a job filled with responsibility that the head of a department must look at with more seriousness than anything else that he does if he hopes to be ready with a good organization when a full time schedule is resumed.

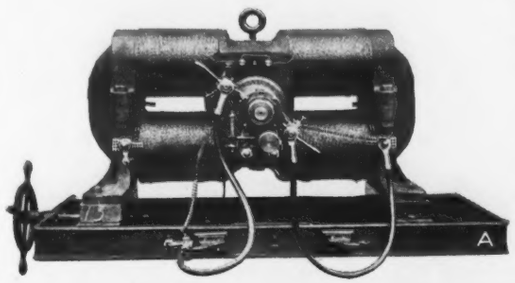
Practical Pete

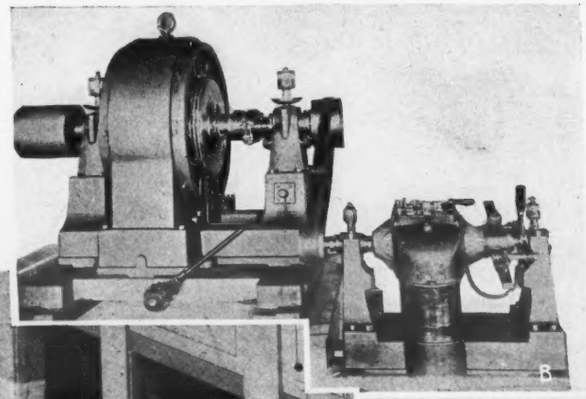
From Old to New in

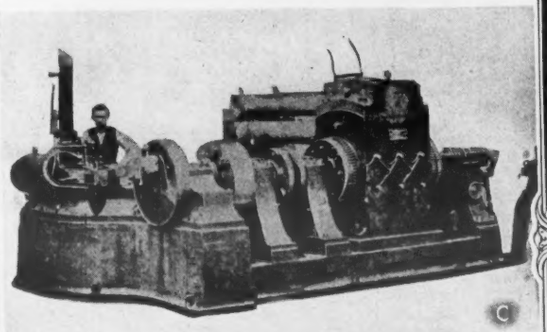
Plant Generator Development

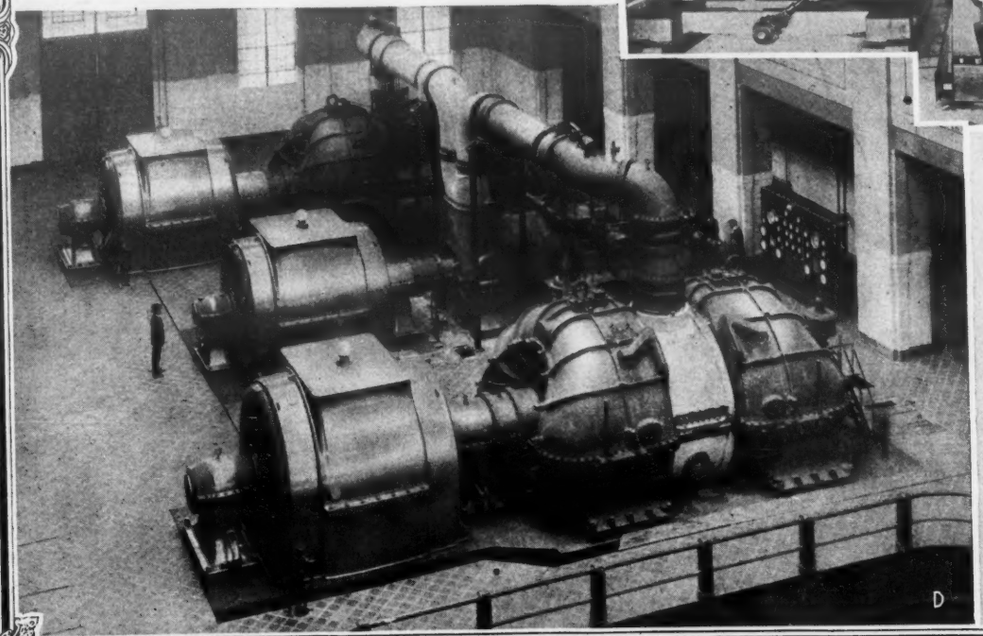
IT IS HARD to realize that only forty years ago Edison's "Jumbo" generators were installed in the first generating station in New York City. Of course Faraday made the first generator much earlier, in 1831, when he rotated a copper disk between the poles of a permanent magnet. Edison made his bipolar machine with upright magnets in 1881, but the installation that marks the beginning of the present system of generating plants in this country was that at the Pearl Street station of New York in 1882. It contained six, 110-volt, "Jumbo" (125 hp.) bipolar generators like that shown at C. The bipolar type of generator continued in use for many years. A Westinghouse machine is shown at A made in 1894.

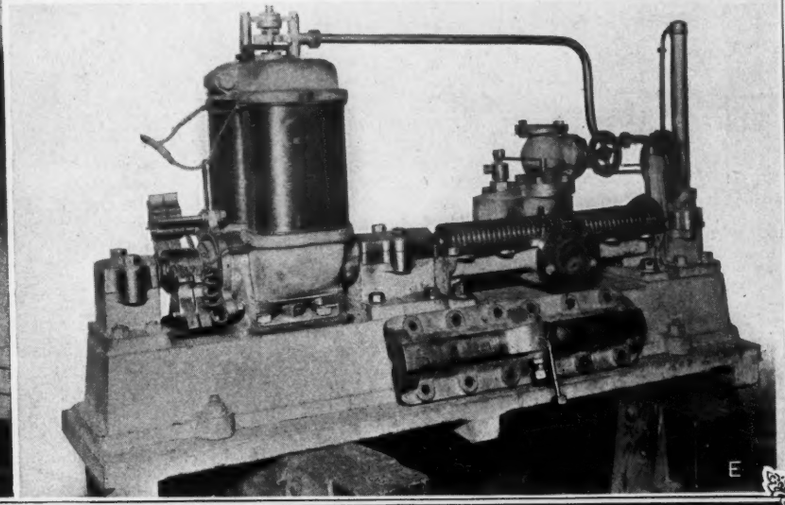
An alternating-current machine was designed in 1832 by Pixii, but William Stanley first employed alternating current commercially in 1885. The early machine had stationary fields like the one that is shown in B. At D is a modern three-unit turbo-generator that is rated at 60,000 kw., 13,200 volts recently put in operation by the Philadelphia Electric Company. Next to this picture is Parson's second turbine connected direct to a 10-hp., bipolar generator operating at the high speed of 17,000 r. p. m. It is interesting to observe that though this machine was built in 1885 the steam flowed in two directions. This double-flow principle is the one used in some of the most modern turbines of today as the photograph of the Philadelphia station discloses.

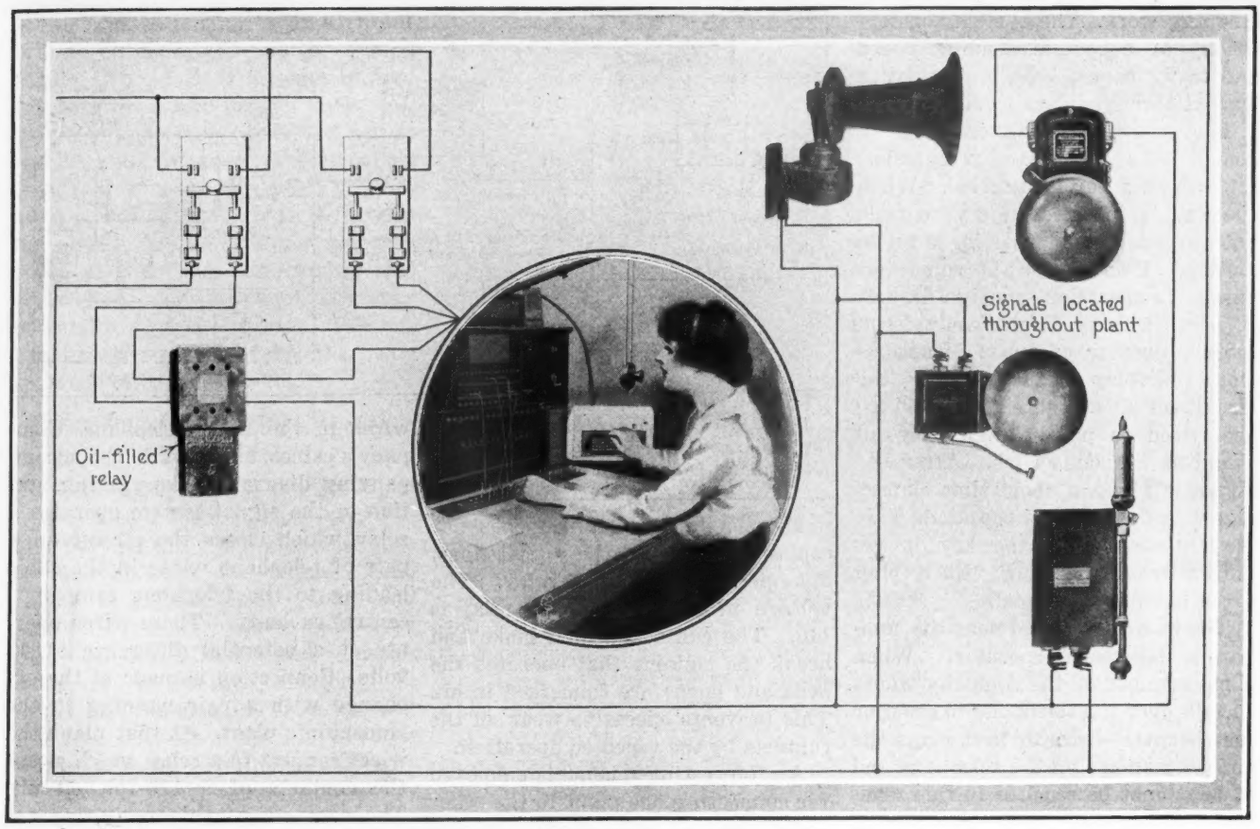

A


B


C


D


E



Reliable Operation of

An Extensive Signal Service

Depends Upon Regular Attention to Small Electrical and Mechanical Details

IN THE plants of the Bridgeport (Conn.) Brass Company the signal systems are regarded as indispensable. Some of these are maintained by the company and some of them by outside organizations. The ones kept up by the plant electrical department are the call system and the watchman's system. In addition this department takes care of a master-clock system and other special systems. An automatic private telephone exchange is also installed. This system and a fire-alarm system are maintained by outside companies.

Some idea of the extent of these systems and how they are used can be obtained from the size of the plant and the kind of work done. There are two plants in Bridgeport, one called the Housatonic plant and the other the main works. In order to avoid confusion, most of the discussion in this article is limited to the Housatonic plant. This plant manufactures brass and copper sheets, tubes, and rods. There are eleven acres of ground, on which are fifteen buildings with five acres of floor space. Thirty-four induction type brass furnaces are operated, rated at 50 kw. and 80 kw. each, about half of each size. Besides these, there is one 2,000-lb. arc furnace.

AS A RULE, signal systems require little maintenance when they have been properly installed. But this does not mean that inspection can be neglected. It is the attention to the little things that develop from natural wear and tear which insures the reliability that is impatiently expected when communicating by signals in a large industrial works. The essential features in the operation and inspection routine of a signal system radiating over eleven acres of ground are outlined in this article.

In the rolling mill are eleven cold rolls and eight hot rolls, all engine-driven. These are 6-in. and 8-in. rolls. Another large department houses drawing machines, tubing machines, etc. An office, an electrical shop and a machine shop, are parts of this plant.

A Signal System Covering Eleven Acres of Ground

A much used system is the one by which a signal is sent to many points in the plant to call various individuals to the telephone. This system also serves to announce to all employees the time of starting and

stopping work. The system consists briefly of a central sending board and many horns, bells and whistles located throughout the buildings.

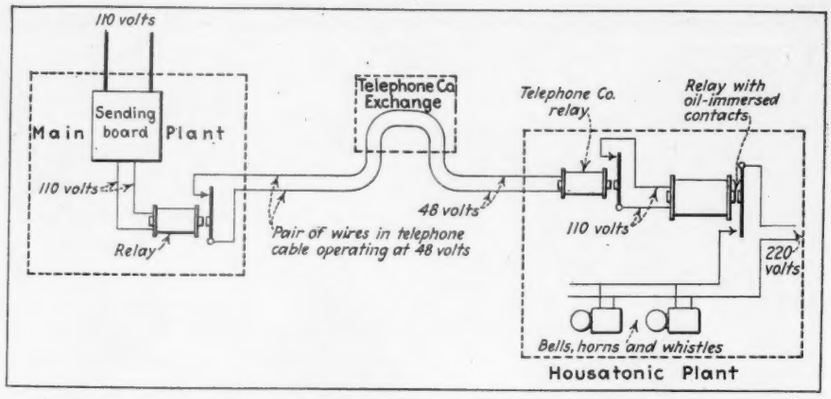
The sending station embodies a board with forty-five receptacles, into which a key is inserted. When the key is inserted in a receptacle and turned, a contact device is set in motion. This device is somewhat similar in operation to a sign flasher. It closes a relay momentarily for a certain number of times in succession, the relay in turn closing the circuit on all of the signals. These are wired in parallel and they all sound at the same time. After the signal is given, a short time elapses and then the signal is repeated. This is continued until the key is removed from the plug. Each plug gives a different signal.

The board is located near the company's telephone operator. When some member of the company wants to talk over the telephone to another member, the operator first rings the second member on the telephone and if he cannot be reached in this manner the operator uses the signal. Each department head has a certain signal represented by one of the points on the board. When he hears his signal he goes at once to the nearest telephone and calls the operator. She advises him of the reason for the call, giving him a connection with another telephone if this is necessary. Often she merely transmits a message which was left by the party making the call in the first place.

Call System Signals Starting and Quitting Time

Another valuable duty of this system is that of announcing the time for starting and stopping work at morning, noon and night. These signals are sent out by the engineer of the power station. A push button at this point operates a relay which closes the circuit. A similar button is installed in the head watchman's office so that he can give the signals when it is desired.

The time for starting work is denoted by one long blast of the horns and whistles and a single tap of the bells. After the noon hour a short warning signal is given two minutes before the time to resume work. Five minutes before quitting time no regular signals are sent out, so that when one long signal is given it is recognized as the time to stop work.



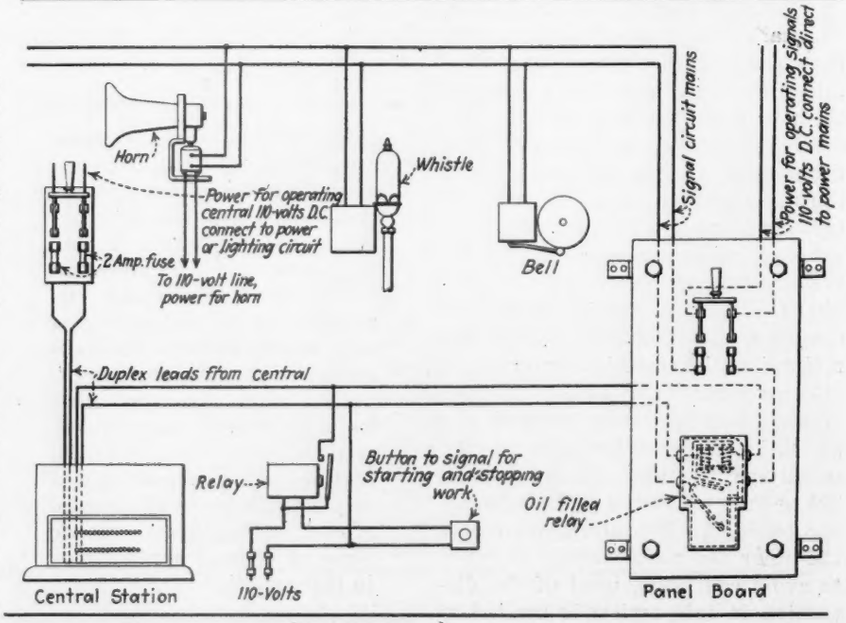
How call systems of two distant plants are tied together through the telephone company's lines.

The sending mechanism does not connect directly to the signal lines, but operates through a relay. The voltage on both sides of the relay is 110. The contacts which make and break the current that operates the bells and horns are immersed in oil. This prevents excessive wear on the contacts by the repeated operation.

An interesting scheme is employed for connecting one plant to the other about one-half mile away. It was desirable to make a connection of this kind in order to have all signals sent from one switchboard at the main plant. City regulation prevented the running of a private line from one plant to the other; therefore, the circuit is made through a pair of wires in the Bell Telephone Company's cables, as shown in the accompanying diagram. The ringing station of the signal system operates a relay which closes the circuit on a pair of telephone wires in the cable leading to the telephone company's central exchange. These wires operate at a potential difference of 48 volts. Connection is made at the exchange with a pair running to the Housatonic plant. At that plant the wires connect to a relay which closes the contacts of a 110-volt circuit. The contacts of this relay are not heavy enough for repeatedly breaking the signal current, so this circuit energizes a second relay, having oil immersed contacts which make and break the circuit across which all the signals are connected. In this plant the signals operate at 220 volts instead of 110 volts. The reason is that the signals were selected to operate on the 220-volt lighting circuit which was originally installed.

Connection is made from the main relays to the signal devices by

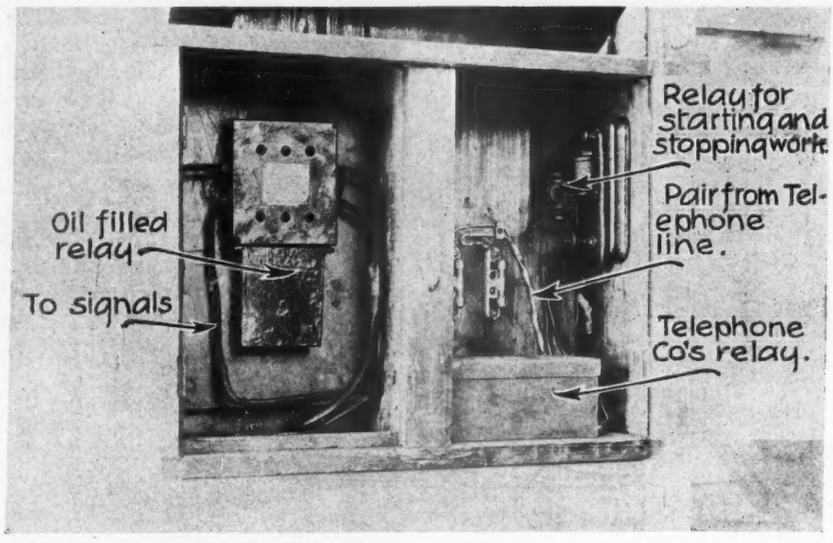
Connections of system for calling department heads of an industrial plant.
When the operator plugs into the sending station, signals sound in all parts of the plant.



means of open wiring. Weatherproof is used outdoors and rubber covered inside. No. 15 B. & S. gage is used for both main and branch lines. All of the signals are connected across the lines so that a two-wire circuit is required. For the horns two circuits must be run. One of these is the signal circuit, which is connected to a relay at the horn. Energizing this relay closes a circuit which furnishes power to operate the horn. The latter circuit is tapped from the nearest 110-volt lighting circuit.

Every Point Is Within Hearing of a Signal

In setting up the signals the object was to locate them so that a man in any part of the plant would be sure to hear at least one signal. This called for signals both indoors and out. In the quieter places bells were installed, while horns and whistles were used in the noisy sections. In offices and the machine shop, one bell was used. In other shops, like those where swaging machines are operated, several horns were installed.

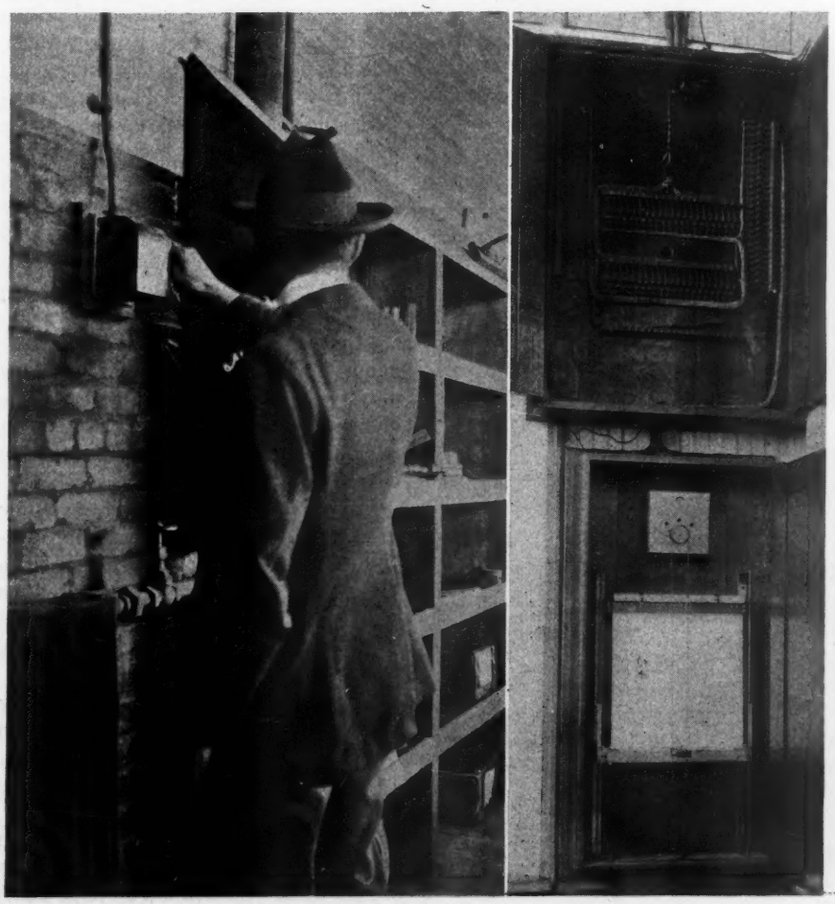


Relays for call system at the Housatonic plant.

The signal comes into the plant at 48 volts on the telephone company's cable. It passes through the fuses to a relay in the small box at the right. This relay energizes the large oil-filled relay at the left, which closes the circuit leading to the horns, bells and whistles. The third relay, mounted on the wall at the right, is used to signal starting and stopping times.

All of the signal devices were mounted high enough to allow the sound to carry well and to prevent their being struck by objects passing by. They were placed high on the walls inside the buildings and under the eaves of the roofs on the outside. In one building shaped like a "T" a special mounting was made. A horn was placed inside this building at one of the central corners of the "T." In order that it would throw its sound along both branches and the stem of the "T" it was mounted on a strap-iron bracket extending diagonally out about 6 ft. from the corner. When in this position the sound could pass into all branches of the "T."

When a watchman turns his key in any station the time and the station are recorded on the sheet at the right.



Horns installed out of doors are protected by a weatherproof case. This consists of a wooden box (page 100), which covers the relay and the base of the horn with a hole cut for the mouth of the horn. This box has a sliding door, so that the parts inside can be inspected. The box, of course, is painted. Some of the whistles were set on top of roofs. In this case a weatherproof box covers the operating solenoid, as the photograph discloses at the bottom of page 110.

In the Housatonic plant there are fifteen bells, four horns and two whistles. The bells are of the single-stroke type made by the Auto-Call Company. The horns are of the Klaxon type, consisting of a small motor which drives a toothed wheel, causing a diaphragm to vibrate. A relay operated by the signal circuit closes a contact which connects the motor to a 110-volt or 220-volt line. The whistles are connected to the compressed air supply of the plant. Their valves are opened by a solenoid energized by the signal current. Bells and horns have given very little

The bells are screwed on wooden backs which are mounted high on the walls.

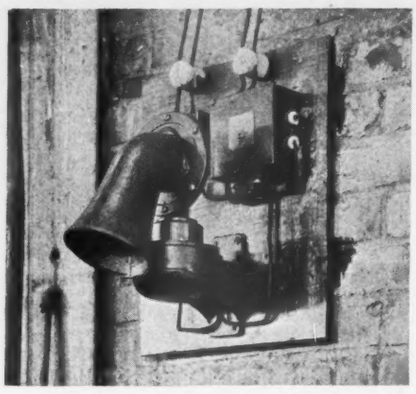
trouble, but the whistles have not been satisfactory. For this reason quite a number of them have been replaced by horns. It appears that moisture condenses out of the compressed air in the valve chambers of the whistles. This causes the valves to stick. Sometimes they do not open fully when a signal is sent and sometimes they do not close perfectly when the signal is completed.

Call System Inspected Every Two Weeks

The entire call system is inspected once every two weeks. Usually very little trouble is found. On the sending board the contact fingers are examined, and the mechanism is oiled.

Before the inspector starts out to examine the signal horns, bells and whistles, he asks the operator to sound a certain signal continuously until he completes his round. The signal chosen may be an extra signal which does not designate an individual. If all the signals are assigned to persons, the operator selects one belonging to the inspector himself or to some other man who knows that the call is only a test. Of course, after the operator starts this signal she may suspend it to send a genuine call.

While the test signal is sounding, the inspector visits each signal to learn if it is sounding properly. If not he adjusts it. The bells and horns rarely get out of order. When they do the trouble is usually that a small screw has worked loose and spoiled the adjustment. If a coil is damaged or the trouble cannot be easily remedied the bell or horn is sent back to the maker for repairs. The whistles, as mentioned before, give considerable trouble on account of water condensing in them. A sticking valve, which this causes, can be made to operate freely by forcing it in and out several times by hand. This removes the rust or other foreign matter. It also blows the water out of the whistle so that it will produce a clear tone.



For noisy places inside and outside, horns give good service.

The oil in the oil-immersed relays is changed every six months, at which time the contacts are inspected.

To make the rounds in the Housatonic plant requires about three hours, or about eight hours per month. This plant has fourteen bells, four horns and two whistles.

Besides this regular inspection each member of the electrical department checks the signals whenever he passes them while a call is being sent out.

The watchman's signal is of the

Whistles are mounted on the roof tops so that the sound will carry far.

This single-stroke bell is the most used type.

kind in which each station has a small magneto that can be turned by the watchman's key. Ringing this magneto operates a relay at the receiving station which pricks a small hole in a traveling paper chart. This records the time and the station which sent the signal. At the Housatonic plant there are thirty-two watchman's stations, with a receiving board that will accommodate fifty.

For connecting the stations with the office weatherproof and rubber-covered wire is used, of No. 18 gage. One common wire is connected to one side of every magneto. For the other side a separate wire is run from each station to the office. This is a considerable length of wire, but as the wire is small its cost is not excessive.

Three watchmen cover the eleven acres at night. Each follows a route which is shown in a map on a wall of the head watchman's office. This map shows the path each man must follow and the location of each station on the route. On Saturday afternoons, Sundays and other holidays only two men are needed, and a route along the docks is not covered. On regular working days no routes are covered.

Each man starts on his route every fifteen minutes. He rings each station and reports back to the office before the next period starts. If a man should fail to report back an investigation is started at once by the head watchman.

Each morning the chart holding the previous night's record is turned over to the works manager for checking to see that all rounds were made properly.

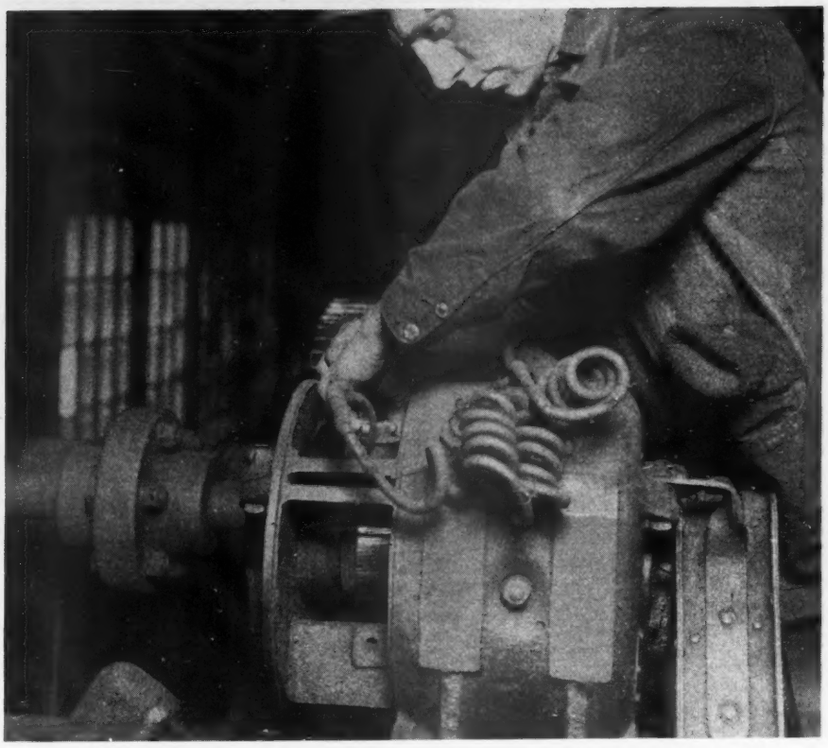
Very little trouble is experienced with this system. Sometimes a wire works loose (*Continued on page* 153.)

Things That the

Crane Inspector Looks for

and Some of the Hows and Whys

By A. L. GEAR
Chief Electrician, Gary Screw and Bolt Company, Gary, Indiana.



The inspector is shown here examining brushes and brush spring tension on a crane motor

THE PURPOSE of the inspection system which is carried out in the works of the Gary (Ind.) Screw and Bolt Company is twofold. First, to locate troubles when they are small and thus prevent interruptions in crane service. Second, to check up on improper operating practices and eliminate the causes of repeated repairs of the same kind on any part of the equipment.

Eight electrically operating traveling bridge cranes are installed. These are Alliance cranes of the stationary and traveling cab types. The stationary cab types are of ten-ton capacity. One ten-ton is used in a short bay having a bridge travel along a bay of only 280 ft., while one three-ton crane is installed on the outside of the main building and has a bridge travel of 530 ft. The others have a bridge travel of 360 ft. All cranes have a hoisting distance of 24 ft. and a bridge span of 50 ft. except the outside crane, which has a bridge span of 40 ft.

Practically all the material used is handled by these cranes a number of times in the course it takes through the manufacturing processes. When crane service is interrupted, the production in the bay in which it is working is seriously retarded in a very short time, since no rough material can be supplied to the machines nor can the finished product be taken from them. Consequently the machines must be shut down. Every effort is, therefore, made to keep the cranes in good operating condition at all times. This is accomplished by systematic inspection at regular predetermined dates, and the preparation and analysis of inspection reports.

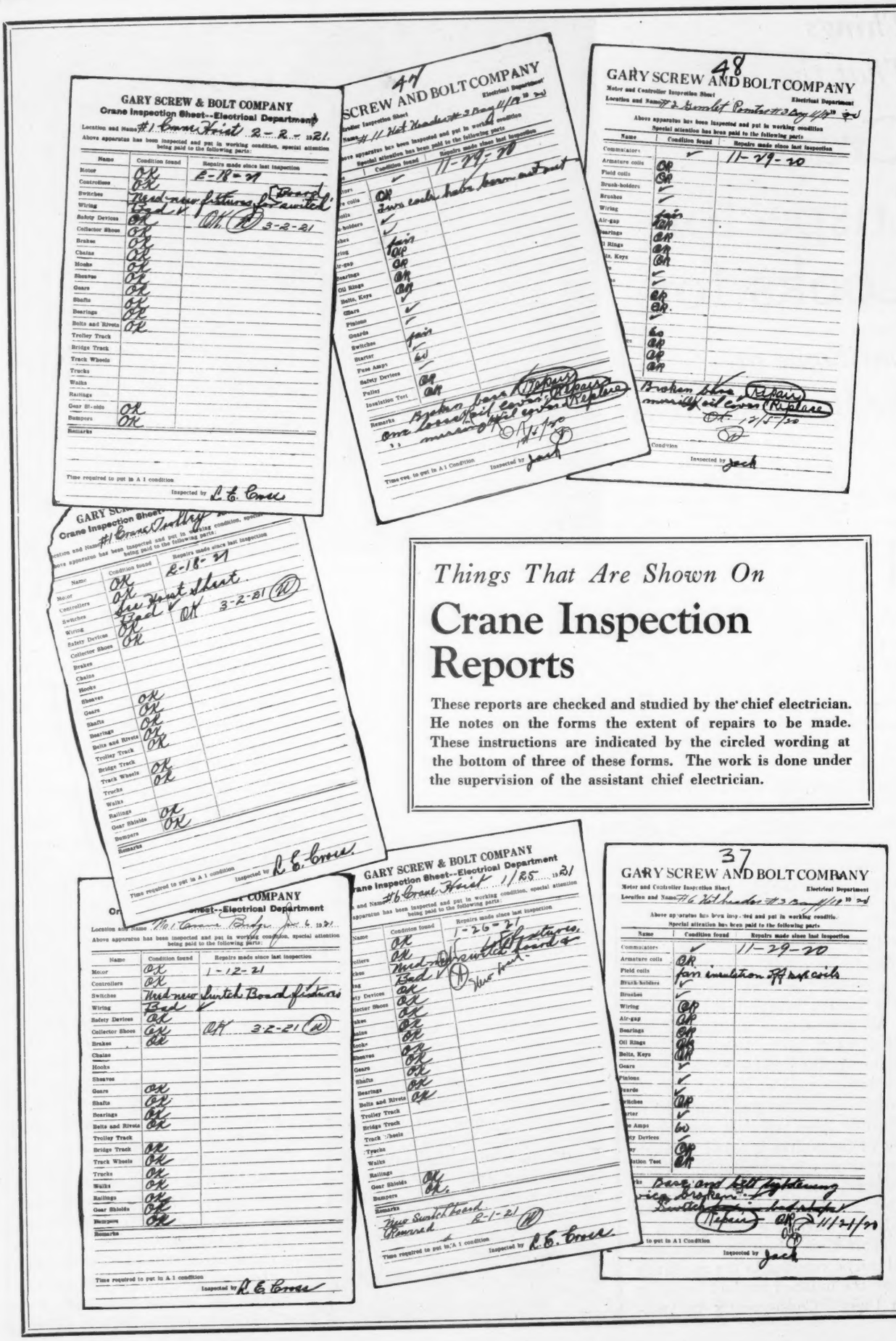
In our plant Friday was selected as a most convenient time for inspection work. A considerable part of this work is done while the crane is in operation, and in fact this is the logical time for an inspection in order to observe crane performance under actual working conditions. Inspections are made by a repairman who is in charge of all crane repairs and works directly under the assistant chief electrician, who in turn is responsible to the chief electrician for all crane operations.

IN THE PLANT of the Gary (Ind.) Screw and Bolt Company maintenance of crane electrical and mechanical equipment has been reduced to a low figure by careful inspections once each week. The system used is a series of reports filed with the chief electrician, who analyzes the troubles as found and directs the repairs needed. These reports are illustrated in this article and details of the inspection procedure are given for each of the items shown thereon, together with some of the essential details of procedure in crane repair work.

Inspection Report Forms

The sheets or forms used in making the inspection reports are shown in accompanying illustrations. They were made up from a copy of a crane inspection sheet, presented in a paper read by J. A. Morgan and J. J. Booth, before the Iron and Steel Association of Electrical Engineers at its 13th annual convention in St. Louis. Certain modifications have been made to suit our particular crane installations. In addition to the use of these forms for locating faults, they have proved of great help in keeping in close touch with all work being done on cranes and the nature of such work.

The procedure in making inspections and filling in the report sheets is as follows: The crane repairman uses a separate sheet for each crane motor, thereby subdividing the crane into three divisions: (1) the bridge, (2) the hoist, and (3) the trolley. Although the trolley and hoist are practically the same piece of appar-



GARY SCREW & BOLT COMPANY
Crane Inspection Sheet--Electrical Department

GARY SCREW AND BOLT COMPANY
Crane Inspection Sheet--Electrical Department

GARY SCREW AND BOLT COMPANY
Motor and Controller Inspection Sheet
Electrical Department

GARY SCREW & BOLT COMPANY
Crane Inspection Sheet--Electrical Department

GARY SCREW & BOLT COMPANY
Crane Inspection Sheet--Electrical Department

GARY SCREW AND BOLT COMPANY
Motor and Controller Inspection Sheet
Electrical Department

Things That Are Shown On

Crane Inspection Reports

These reports are checked and studied by the chief electrician. He notes on the forms the extent of repairs to be made. These instructions are indicated by the circled wording at the bottom of three of these forms. The work is done under the supervision of the assistant chief electrician.

Three-ton crane with traveling cab provided with scales

View looking down bay No. 6 with No. 7 to left and No. 5 to right. The bucket being carried by the crane is of the regular type used to hold and carry nuts and rivets. The scales for weighing the load may be seen just beyond the cab, the end of the scales extending slightly to the right beyond the cab. Seven other cranes of three-and ten-ton capacity are in use in this plant, two of them being in service outdoors in the stock yard. Each inside crane serves an entire bay in the building. The crane shown has a 50-ft. span and is standing at about the center of the length of the bay which it serves.

atus, two motors are used in this case, therefore two report sheets are required. The repairman doing the inspecting makes the reports as shown in the illustrations, reporting on apparatus found "O. K." as well as that needing attention. Upon completion of the inspection the report is given to the assistant chief electrician, who examines each item and then turns the complete report in to the chief electrician, who in turn also examines the inspectors' comments and checks in red those repairs he desires made immediately. It is the usual practice to add a notation of the extent to which the repairs should go. By this second check the chief electrician is always posted on the condition of the cranes. It also prevents the crane repairman from taking a crane out of service that cannot be spared on inspection day (Friday) or the following day, which is usually a half day.

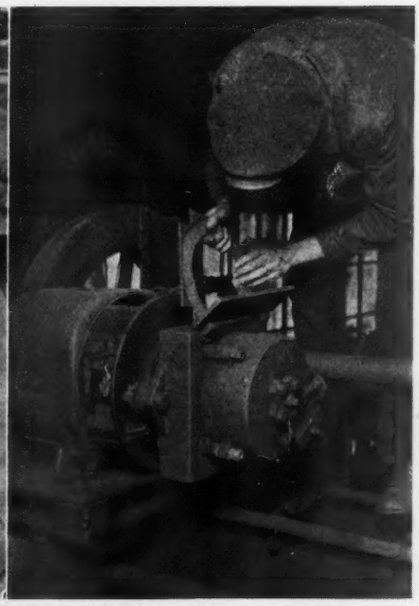
Things Looked for in Making Inspections

The following details inspected by the repairman on a hoist motor may be considered typical of other motor inspections. As shown in the accompanying illustrations, taken during a regular inspection period, something more than a casual investigation is made. The operations other than motor inspection that he performs are taken up here in the order of their importance, as recorded on the inspection report forms.

Hoist Motor Brushes.—He first examines the commutator brushes. Those fitting in box holders he tries for free movement up and down through the brush holder. This will tell if dust or grit has accumulated upon the sides of brushes, tending to make them bind in the holders. Then he pulls up the tension spring finger that presses down on the top side of the brush to see if the proper pressure is exerted upon this brush, forcing it in contact with commutator surface. From 2 to 2½ lb. per square inch of contact surface is usually sufficient. The repairman is reminded that he is measuring the pressure of the finger at the top surface of the brush upon which it is supposed to rest. He should not measure the pressure at a point where the finger is raised one-half or one inch above the top surface of the brush. If the brush pressure is all right, he takes the brush out of the holder, as shown on this page, and examines the contact surface on commuator. If it is a smooth polished surface with no scratches and no burns on the toe or heel, it is in fair shape. It is noticed whether the toe or heel are sharp lines or flat surfaces. If either toe or heel is a flat surface, the brush does not fit the arc of the commutator and should be resanded or the brush holder turned slightly up or down, depending upon which is the flat surface.

Inspecting brush, commutator and connections of crane bridge motor

Every visible part of the motor is looked over for signs of weakness. Burns on the commutator indicate open circuits in the armature, high mica, etc. Loose connections or frayed insulation will cause trouble in the near future if not corrected. It will be noted that the brush has been removed completely to facilitate the work, and it may also be noted that the face of this brush is without broken or chipped edges.



Inserting stationary brake section in crane motor brake

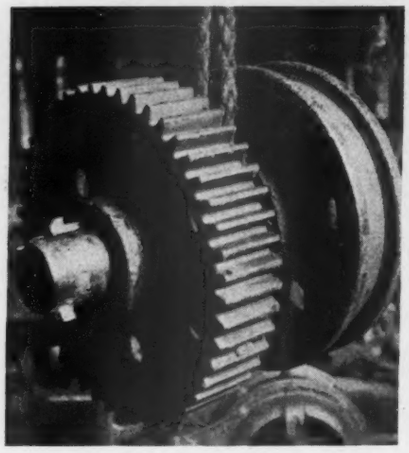
This automatic brake is actuated by a magnet coil in series with the motor and a spring working against the coil. When the motor circuit is closed the magnet overcomes the spring pressure and releases the brake, allowing the motor to operate. When the motor circuit is opened the spring sets the brake and stops the motor. New brake sections are inserted through the lid over the top of the square enclosing box. Square cast-iron stationary sections and round steel sections, moving with the armature shaft, are used.

If the brushes are in good shape he replaces them and examines the brush-holder leads. These are usually of stranded cable and in time vibration may cause the copper to become brittle and break some of the strands, decreasing the cross-sectional area of the cable below the required amount. This may result in the cable being burned apart at the weak point when a large current flow is caused by a heavy load upon the crane hook. This would shut the crane down just when it is most needed. There is a lead or cross connector on each brush holder and both lead and cross connection on half brush holder in machines having more than two brush holders. In machines having only two brush holders there are only the brush lead wires. If these leads are well soldered to the connecting lugs or firmly held by screws, with no places where insulation is rubbed off, and no broken strands, the inspector may call them "O. K." and go to the field coils.

Field Coils.—The field lead wires should be of ample cross-sectional area to carry the current required by the motor at maximum load. After tracing these field leads back to the series field coils (since crane motors are series connected) and finding them in good condition, he tries to shake or move the field coil on its pole piece. If it does move, it must be tightened, as this movement will in time wear the insulation off the wires of the coil and cause a grounded circuit.

Commutator.—The commutator is examined for high mica. This may be tested by holding the finger nails at right angles to the commutator surface and drawing them around the surface. An experienced repairman should, as a rule, be able to detect commutator trouble by the color of the commutator when such trouble has developed at a particular point.

Open circuits in the armature are very evident by the burning across of the mica at the point of open circuit. However, in a wave, single-series, four-pole, two-brush armature an open circuit will show at two points which are practically diametrically opposite each other. When an open circuit is found the armature should be taken out and replaced by a good one without delay, but if the crane cannot be spared a temporary repair may be made by bridging the mica at the point of the open circuit with metal, usually copper. This can be done in most cases by taking a screw driver and tapping lightly until the blade has forced a very small portion of mica out from between commutator bars at the point where the winding shows an open. Then with the screw driver force a very small sliver of copper from a commutator bar into this hole. This piece of copper will act as a bridge and cut out the armature coil between the commutator segments.



Crane bridge wheel and driving gear removed for repair.

This wheel with its connected gear has been removed because of wear on the face of the wheel. The key locking the gear to the shaft is prevented from working loose by a bolt head in the slot of the shaft. This bolt head is just visible at the end of the key, the nut on the other end of the bolt being in plain view at the lower side of the shaft. Keys locked in place in this fashion may be easily removed.

It is not practical to "cut a commutator to pieces" shorting open circuits, neither is it practical to delay a crane one-half hour when there are several tons of steel in a single furnace or ten furnaces are working. If the delay is of any length, the steel is very likely to burn and scale. The writer does not like the practice of shorting a commutator to correct opens in the armature, but has ordered this to be done when the occasion has demanded it.

The commutator should also be examined for grooves cut in by brushes, as the armature should have a slight end play and not be pinched between bearings. This will cause hot bearings. Also a slight play helps the oiling. The inspector examines next the string band at the outer end of the commutator. I this should come off the mica V-ring is very likely to flake up and tear, due to the air pressure caused by the armature speed. The band just behind the soldered armature connections should next be examined. Then glance through the space between armature and field poles. If an armature band is broken, evidence of it can usually be seen quickly.

Motor Brake.—The inspector turns next to the multiple disk brake on the commutator end of the armature shaft. This brake is for the purpose of helping stop the hoist and lower-

Testing the bearings at pinion end of crane motor

In making this test a heavy screwdriver or similar tool is inserted between the teeth of the pinion and its gear and they are pried apart to note the play of the motor shaft in the bearing. It is essential that the inspector know the air gap length in order to judge how much play can be allowed. Wear of these bearings may also be judged by the depth of mesh between the gear and pinion.

ing movement of the crane hook. In the installation under discussion it has four stationary and three revolving disks upon which pressure is applied by a spring when the motor has no current flowing through its winding. But this spring pressure is removed upon current being applied to motor by an electromagnet which pulls a plate against the spring pressure, thus relieving the disks. They are then free to rotate without friction. After being satisfied that this brake is in good working condition, the inspection of the commutator end of the motor has been completed with the exception of the bearing. This may be easily tried for wear by reaching one hand around each side of commutator and clasping them under the commutator by interlacing the fingers. Then, by lifting up on the commutator, any movement of the shaft in the bearing may be felt. It is always advisable to carry an ordinary paint brush along on inspection work so that dust and dirt may be brushed away and make it possible to see the parts clearly.

Motor Pinion, Bearings and Keys.—The inspector next looks at the pinion at the rear end of the motor. There are not a great many parts that can be examined from this position, but the bearing wear may be tried by inserting a screw driver between the motor pinion and gear teeth, as shown on page 114, holding the motor armature from rotating meanwhile. By using a small pressure up and down an excessive amount of shaft play in the armature bearings can be easily felt. This also will show up by an examination of the meshing of the gear and pinion teeth. These, however, should be examined for wear and lubrication; also for proper mesh.

Connections between supply lines on building structure and crane bridge

Two sets of collector shoes are carried by the single supporting arm. The heads of the bolts supporting the two separate upper shoes may be seen at either end of the insulating board at the lower end of the arm. Only one set of bolt heads are visible for the lower shoes, the other set being cut off from view by the flange of the main bridge girder. Leads between the collector shoes and the bridge trolley bars are run in loom for protection.

It is good policy at the time the bearings are examined to look into the condition of armature shaft keys and keyways. If the key is too loose for the keyway, this may be seen by the movement which the key has made during operation of the motor. It has been the writer's practice on cranes to drill through the shaft whenever convenient just behind the key head and put a bolt through the shaft with a head of such a size that it will approximately fill the keyway in the shaft. A split lock washer and nut is used on the other end of the bolt.

Controller.—The next inspection point is the controller for the motor. Only minor repairs are done on this on the crane. If a controller should require repairs of any extent it is taken out and sent to the shop and replaced by one in good condition. The inspector examines the contact arm brushes for pressure upon the contact segments, looks at the pressure spring to see that it has not overheated and lost its curvature. This would, of course, decrease its spring action and thereby limit the brush movement until it finally becomes practically inoperative.

The contact segments should be smooth, unblistered and show no excessive burning at the edges. If burning is allowed to continue it will widen the space between segments until the brush, tilting slightly, will stick at this point and not allow full sweep of the contact arm. This, of course, occurs only upon controllers having face plate contacts, not upon finger and drum contact controllers which have no segment contacts on the face.

The controller contact arm is tried to be sure that it has not become loose upon the center post or axis upon which it rotates. The resistance unit, if grids are used, may be inspected by unscrewing the back of the controller. However, this is not universal practice, because if the resistance becomes open it shows up readily enough when one tries to operate the motor.

Cab Switch.—After looking over the controllers and recording their condition on the report sheet, the inspector passes on to the switch on the cab switchboard. In our plant only one switch is used; we feel that others are unnecessary and only an additional expense. If work has

Controllers in cab of three-ton crane

Rugged equipment is required in crane service. Clamps holding the conduit to the left hand cab suspension, it will be noted, are made of heavy stock. There is no frayed or loose insulation on the ends of the leads connected to the controller terminals.

to be done upon the crane which has no auxiliary hoist, the entire crane may as well be inoperative. Therefore, a main line switch only is installed and a separate set of fuses for each motor of such a capacity as to protect its own motor circuit. Main line fuses are provided ahead of the main line switch. This switch and all fuses are back-connected, leaving the face of the switchboard in the cab as nearly dead as possible.

The inspector examines the switch for loose contacts on the studs at the back, on the blades, and also at the hinge spring clip and blade receiving lug to see that both sides of this lug firmly clamp the blade with spring pressure when the blade is inserted. The crossbar of insulation between blades should also be examined to make sure that it is not absorbing excessive moisture, which will eventually cause this insulation to carbonize and form a short circuit across the blades. This should be especially watched if the crane is exposed to the weather and the switchboard becomes wet from rain.

Crane Wiring.—In inspecting the wiring, which the inspector examines next, he traces all conduits to make sure that there are ample pipe straps for rigid support; that all condulets are in proper condition and not cracked; that conduit is firm in the condulet; that all condulet covers are screwed firmly on; that there is no cracked porcelain; and if fiber is used that it is not water or oil soaked; that all conduit open ends have conduit bushings screwed firmly on.

Collector Shoes.—After the wiring inspection, the repairman usually goes to the collector shoes, the main collectors and trolley collectors, which can be inspected at the same time. This plant uses two sets in parallel (see page 115), so that in case trouble occurs with one set, the crane operator or crane repairman may lift one set off and allow the crane to continue operation with only a momentary delay. By using two sets in parallel, the arc is reduced considerably. This arc is usually caused by poor or worn joints in the trolley bar, by moisture or oil upon trolley bar or in new shoes by poor contact with the trolley bar. Collector shoes are allowed to wear fifty per cent, as this does not seem to give trouble, but if allowed to wear much deeper, trouble shows up in breaking collector shoe board or bending trolley staff. Contact with the trolley bar is purely a matter of their weight upon the bars, as spring pressure has caused considerably more trouble. A flexible wire or stranded cable is used bolted to the collector shoe to take off the current which is rarely more than one hundred amperes. Should the current be greatly in excess of this amount some better method of contact should be provided.

Chain that has been damaged by stretching

Overloading chains until they stretch causes the links to lock so that the chain becomes stiff. The chain shown in the illustration has been badly overworked and, as may be noted, is no longer pliable. The entire weight of the chain is being supported by the seven horizontal links. Other links below the hook in the illustration are also locked because of stretching.

Gears, Shafts and Bearings.—The next point of inspection is the gears, other than those directly connected with the motors. The inspector looks for cracked spokes, cracked at rim, mesh, worn teeth, alignment with other gears or pinion into which it is meshing, lubrication of teeth, and fit on the shaft. At this time the shafts may be inspected for alignment, straightness, end play, key seats and the like. In inspecting the shafts he looks into the bearing condition as he goes along, especially the bearings of the bridge drive wheels, which must not wear too much. In such a case the end of the bridge having the unworn bearing will lead in bridge travel up and down the track and soon wear the inside flange of the wheel on the other end of the bridge. When bearings on any shaft working gears are allowed to wear excessively the gears will not mesh properly and cause excessive tooth wear. This may cause the gears to pull apart and strip off the teeth under heavy loads. In the case of a crane load, this may cause serious damage not only to the crane but to the machinery under it, if not injure workmen on the floor.

Trolley and Bridge Tracks and Wheels.—The trolley and bridge tracks are inspected next. To be sure they are securely held down to the crane runway, but looking along the track is a practical check for straightness. Occasionally the center distance of rails should be checked up at a number of points along the runway with a steel tape. This inspection, however, requires two men. Any movement sidewise of the rail under its holding down lugs may usually be checked by walking along the rail and looking to see if dust and sand is moved upon either side of the lower flange of the rail. If there is movement it can easily be detected. At the same time the inspector looks for flat spots on the ball of the rail. These may be found at a point where there is frequent stopping and starting under heavy loads or reversal of travels.

In inspecting the track wheels, the inspector looks for flat spots, chipped or worm flanges. He looks to see if either side is rubbing from excessive

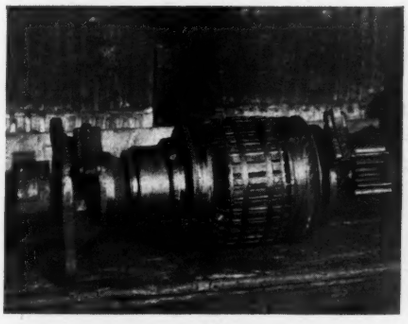
Winding heavy wire coil for crane armature

When winding coils with stiff wire the operator uses both hands to turn the form. When light wire is used the form is rotated by means of the handle, using one hand to turn and the other to guide the wire. Coils when wound are held in form by small clips made of light sheet metal. These clips are removed when the coils are taped. Soft coils for induction motor windings are tied with wire instead of being held by sheet metal clips. Coils of various lengths may be wound by setting the spools at different positions along the rotating arm. Spools of different dimension are used for coils of different size, the width of the slot determining the width of the finished coil.

end play of the shaft, as the wheel is usually shrunk on the shaft. The trucks are inspected at the same time. He looks for loose nuts, bolts and rivets. This may be done by a close inspection of the metal around the head of the nut, bolt or rivet, and may be also tested by sound when tapping the head lightly with a light hammer.

Walks and Railings.—Walks and railings are inspected for breaks or splits, when made of wood, and for loose corners or edges, when made of sheet metal. Fastenings are inspected to make sure that they are tight on both walks and rails.

Gear Shields and Bumpers.—The gear shields are inspected to make sure that they are rigidly secured in place and properly protect workmen from coming in contact with the gears. The bumpers are inspected for secure fastening, ample size and alignment. If the bumpers are out of line and the crane comes against each bumper, the crane is out of line with the track upon which it is to operate. Rivets on the crane structure, and there are a great number of them, can be inspected for movement of the head by tapping with a light hammer. This is about as fast and as practical a way as the writer has been able to find.

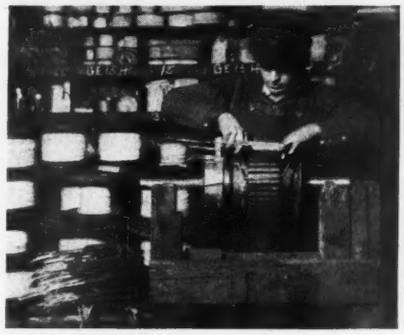


Spare armature ready to replace a defective unit

Complete armatures with bearings, pinion and brake hub in place are held in stock ready for immediate use. In case of a broken pinion, worn bearing, damaged commutator or winding, a complete unit can be inserted in place of the old one in less time than it would take to renew only the damaged individual part. With all the parts fitted together there is no chance that the repair pieces will not fit where they are supposed to go.

Sheaves, Hooks and Chains.—The inspector now leaves the crane structure and returns to the floor to inspect the sheaves, hooks and chains. The sheaves are inspected for cable fit in the grooves, shaft fit upon which they rotate, lubrication, which is accomplished on Alliance cranes of the older types by a grease compression cup upon each end of the shaft upon which sheaves work. The hook is then inspected for wear and straightening out, although the writer has never had an Alliance crane hook straighten out, and for free movement parallel with sheave rotation; also for hook rotation and lubrication.

The crane chains are inspected for wear, stretching of links and, if there is a double chain on the ring, for equal length. It has been a practice to anneal all crane chains in the plant at least once every three months, and in real cold weather the annealing may be oftener. A chain will not break as quickly upon being given a jerk when it is warm enough to keep frost and chill out of iron. This annealing releases strains in the chain links.



Starting to wind a crane motor armature

The lower leg of the first coil is already in place, and the second coil is being inserted. The slot insulation used consists of empire cloth and leatheroid with the empire cloth next the coil and the leatheroid next the armature core. A portion of the stock of wire, coils and other materials and supplies may be seen in the background. Complete armatures are kept in stock ready for immediate use, and materials are available to do any job that may be required.

After some experience in careful inspection work a repairman will soon become familiar with the routine and it can really be accomplished more quickly than it would at first seem possible.

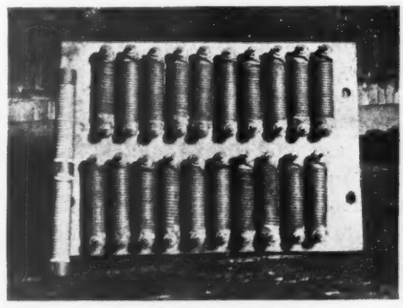
Analyzing Reports for Faulty Operation

The analysis of reports is as important as the inspection. In this way it can be observed if the same repairs are required often and the cause located and corrected.

A considerable portion of crane troubles may be caused by fault of operation. It is always advisable to closely watch the crane operators for a day or two and make sure they are operating correctly. Repairs may be greatly reduced in this way. For instance, sudden starting and stopping is hard upon a crane, so is striking bumpers heavily and pulling loads along the floor at right angles to bridge movement. In the last instance, this is hard service on the crane cables, for cable drums are usually grooved to receive the cable. Swinging the load to a spot beyond the actual reach of the crane is hard upon all trolley apparatus.

Bad Effects from Plugging.—Plugging is usually objectionable because of its effect upon the electric system. It should be eliminated as much as possible with special precautions taken against its effects. However, it is sometimes permissible when the crane is crowded with work and far behind, but the apparatus usually pays in the end. The crane pays in the loosening up of bolts, nuts and rivets, causing flat wheels and breaking of controller grids should they be of small cross-sectional area and long distance between supports. Also the alignment of the crane with the track is thrown out. There is also a severe strain put on the electrical insulation, which usually shows up in a grounded armature.

If rapid operation can be secured without plugging it is decidedly better to avoid the plugging. At the moment of plugging flash-overs are likely to occur at motor commutator, or flash-over to ground at the ends of armature teeth where the coil bends around; at ground detector



Wire wound resistance units for use in crane motor control

The short units mounted on the board are held in place by bolts running through the board and through the ends of the spools. A new type of unit, shown at the left end of the board, is to be substituted for the shorter units. This new unit is complete in itself and will be connected into the circuit through the medium of clips similar to those used to receive cartridge fuses. The clips will be connected solidly in the circuit and the resistance unit will be free to be removed and replaced without the use of tools or the removal of any connections.

lamps upon switchboard, in some cases bursting them or burning up the receptacles which hold the lamps. It possibly may not show up in the crane electrical equipment itself, but in some other part of the system. In this plant it seems to center upon the lathe motors of the same circuit, in the tool making and repair department of the machine shop. Here considerable trouble was experienced from flash-overs at the commutator end of motors until orders were issued that crane men must not plug beyond the first resistance point. It was surprising the motor trouble this eliminated.

As mentioned, sudden starting and stopping are to be avoided as much as possible. In addition to the saving in power thereby secured, it is a decided lessening of crane repairs. A crane should be operated as smoothly and free from jerks and bumps as possible. In another article the writer will take up details of repair work done on the crane and in the electrical repair shop.

However carefully a crane is operated the need for repairs must always be anticipated. Inspections, however, locate small troubles before they grow big enough to cause a shutdown.

Practically all crane repair parts are made in our plant. The machine shop makes all pinions, shaft keys, bearings and guards. The crane cables, large cast steel blanks, carbon brushes and disk brake plates are purchased. All machine shop work on gears and brake plates is also done in our own machine shop and all electrical work in our electrical repair shop.

Changes to Reduce Repairs.—Certain changes have been made that have resulted in quicker and cheaper repairs. For example, the original disk brake plate was covered with a riveted asbestos sheet over the metal plate. This would tear off and ball up between the plates, causing an uneven pressure and breaking of plates. A cast-iron plate is now used in the plate box just as it comes from the foundry, requiring no special riveting work nor the addition of other material. This saves both time and material and gives better results. The revolving plates are sheet steel made in the machine shop to fit the brake box and the brake hub. These have given good results, but require machine shop work. We are now planning to use a plate of cast steel, eliminating the extra machine shop work on steel plates. The cast iron plates adjacent have proved successful. On page 113 a workman is shown inserting a square cast-iron brake plate in the electric disk brake box of a hoist motor.

Resistance Grids.—At one time considerable trouble was experienced with cast resistance grids on swinging cranes, while only a small amount of trouble was experienced with the spool type resistances on the same cranes. Also the grids as a unit did not seem to have the resistance required for the smallest motors to prevent them from starting suddenly with a jerk. It was, therefore, decided to use spool type German silver resistance units throughout. A set of these spools or tubes were calculated and built to fit the present controller frames. On page 117 one the first sets used is shown. This set has worked splendidly, but was taken out a short time ago after many months' service to be tightened up, as nuts were working loose upon the resistance tube ends. As may be seen from the illustration, each tube is fastened by a bolt and nut. This unit gave good results as far as operation was concerned, but it was sadly lacking in ease of repair. Therefore, another unit was designed with the same resistance, but more compact and decidedly more accessible for repairs. This new unit is also shown on page 117, beside the former design.

This new resistance unit consists of a round wooden tube heavily covered with asbestos paper tightly wound. At each end and in the center are cast-brass collars or ferrules similar to a fuse ferrule. The German silver wire is wound between the ferrules and the end securely fastened under a ¼-in. bolt head which passes through the first side of ferrule and screws into a threaded hole in the opposite side. The unit or tube is then pressed into three spring clips, the same as used for 80-amp. ferrule type fuses. All clips are back connected. Accessibility for repairs is readily seen, for should a unit burn out, it is pulled out the same as a fuse and a new one inserted in the clips and the crane is ready for operation. It is impossible to state what may be considered the life of a tube, as those installed have given no trouble since installation some eight or twelve months ago.

Rewinding Jobs.—All armature, field and brake-magnet rewinding is done in the electric shop. This is done as simply and rapidly as possible consistent with good workmanship. On page 116 a workman is shown winding heavy armature coils upon a home-made coil winder. This simple machine has proven very easy to operate and exceedingly accurate. When a set of coils is wound in this way they are all of the same length and have even, tight sides upon each layer of wire. The wire tension is usually applied upon the spool. The coil is fastened with either four or six tin strips securely holding each turn in place before being removed from the coil winder. As may be seen from the illustration, coils of various lengths may be wound upon the same winder. Also, practically any number of wires in parallel can be used. After the coils are wound and the tin clips are in place, they are removed from the winder and baked, then dipped in thin varnish and baked again. Sleeving is placed on the leads and they are taped with cotton tape. They are then formed or spread by a home-made coil spreader, which consists of two flat pieces of wood, say 10 inches wide by 18 inches long. On one end of each is screwed two pieces of hard wood, the space between being wedge shaped with the back side straight or 90 deg. with the edge of the board. The front side slants to form the wedge-shape space. The top board of the former is practically the same, only the front piece is of hardwood and is placed at 90 deg, with the side edge of the main board, allowing the back hardwood piece to slant. The coil is then placed between these hardwood pieces, one board resting upon the other, and wedges are driven between the hardwood pieces with the coil clamped firmly on each side. When the top board is pushed away from the operator, the coil can be stretched to the spread required by the armature coil pitch.

Coil Treatment and Special Tests.—The coils are baked in an oven until all moisture is dried out of the cotton covering. They are then dipped in varnish, and allowed to soak until all air bubbles have ceased. Then they are removed and baked again. After baking they are ready for use in winding the armature. The armature core has previously been inspected and all sharp coil-slot edges filed. The commutator has been tested for shorted, loose or grounded, (*continued on page* 152.)

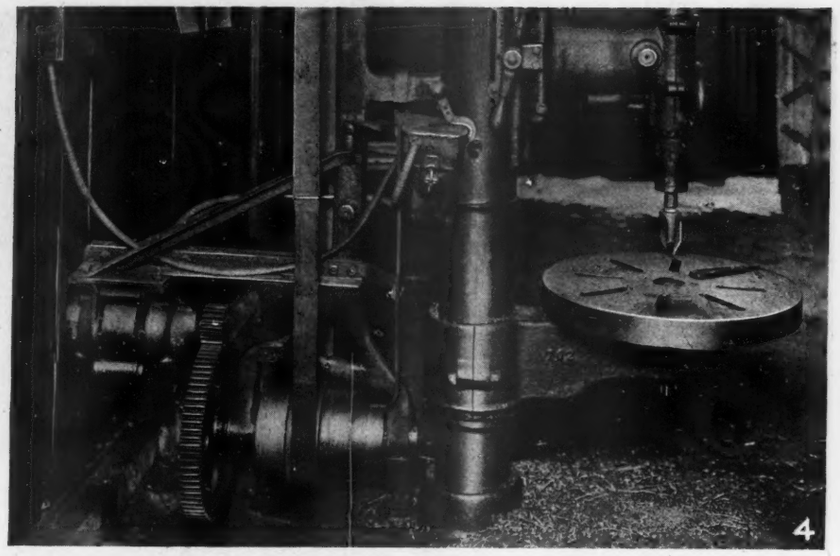
Some Ways of

Using Structural Steel

in Mounting Motors on Machines

By A. S. MILL

Master Mechanic, Eastern Bridge & Structural Company, Worcester, Mass.



"There's nothing like keeping motors out of the way to please a shop superintendent," says Mr. Mill, and this is one of several ways he has devised to do both.

IN EQUIPPING formerly belt-driven machine tools with individual motor drives, we have found standard structural steel shapes very useful. Our line of business makes it easy to find odd pieces about the shop which can be worked up into motor supports with little loss of time, but there is no reason why industrial engineers generally could not take advantage of such standard shapes. In many cases a lot of time and trouble is taken to secure special brackets and castings which could just as well be put aside in favor of the standard plates, channel-irons and I-beams so widely available.

The accompanying illustrations are from photographs taken recently in our shop at Worcester of machine tools equipped with motor drives after a previous service under belt driving. Fig. 1 is a Hilles & Jones No. 3 punch connected by gears to a 7.5-hp. motor. The motor is mounted on a steel plate; a thickness of ½-inch would have been adequate, but in this case we had a 1-in. plate on hand and used it. The plate is bolted to two 5-in. H-section members, which in turn are bolted to 3-in. I-beams bolted into a sand-tamped wooden foundation made up of six 12-in. by 12-in. timbers laid in sets of three, piled crosswise. This does away with the use of a concrete foundation and gives a good bearing even for heavy machines. We can change machines around with this sort of a foundation, as factory conditions demand, and are independent of the rigidity imposed by using concrete.

When we had to mount a 10-hp. motor on a Long & Allstatter shear not long ago, the scheme shown in Fig. 2 was used. By cutting one leg of a standard 6-in. by 6-in. by 1-in. angle-iron and welding the parts with an acetylene torch, we secured a strong band at the left-hand end of the improvised bracket shown. This made it possible to mount the motor on an inclined side of the machine-tool frame in a place which ordinarily would look like a poor one to mount anything upon. The diagonal braces shown at the right-hand end of (*Continued on page* 152.)

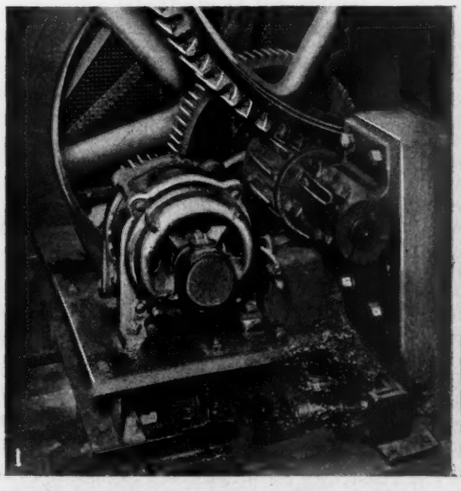


Fig. 1—By putting this motor on a steel plate supported on standard H-section members, it was firmly mounted close to the flywheel of the big punch shown in this picture.

Fig. 2—It required a little ingenuity, a standard angle-iron and a welding torch to attach and line up this motor on the sloping side of a "husky" shear.

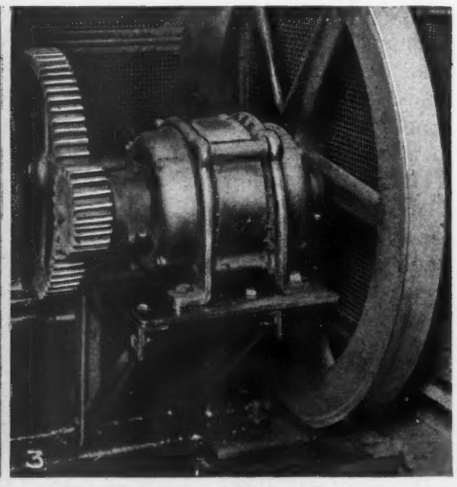
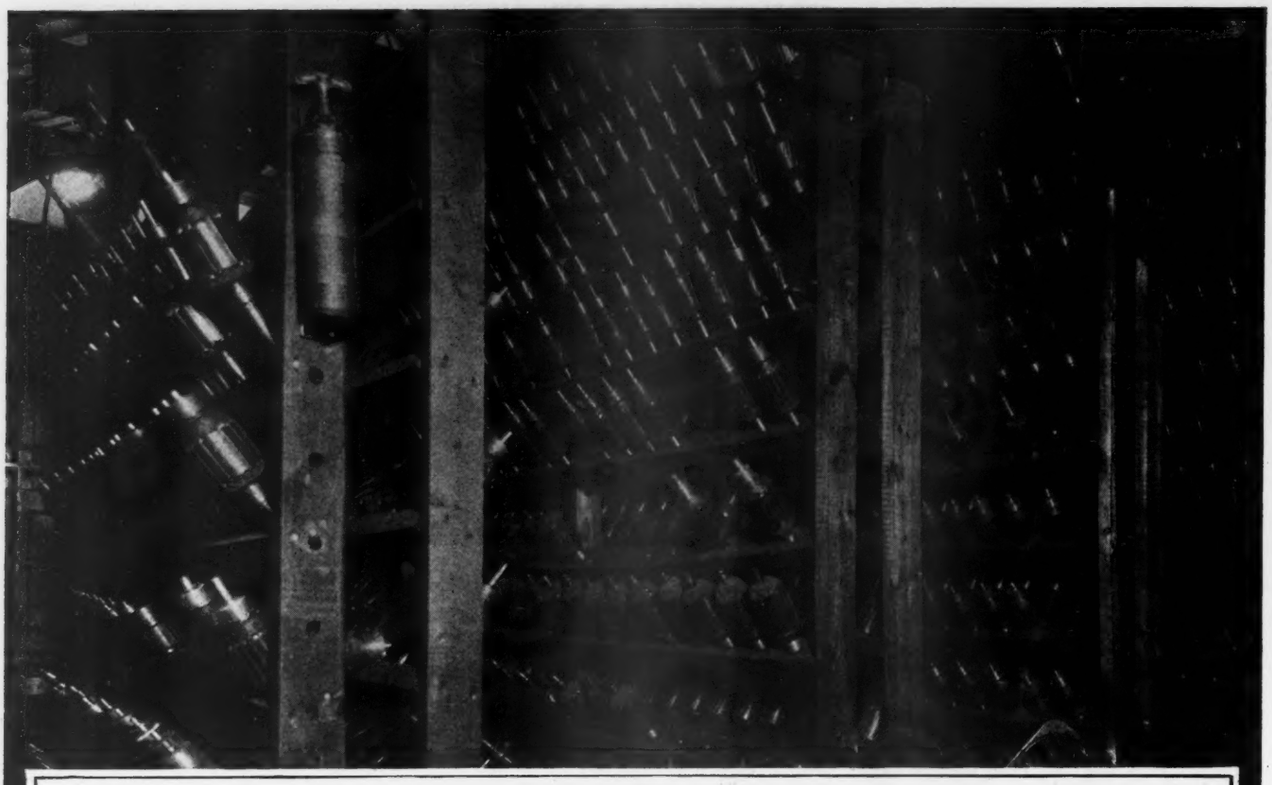


Fig. 3—This simple scheme of making up a motor bracket out of a few angle-irons and a plate may suggest a solution for some other "close quarter" motor drive.



Organized Procedure by Which

Ten Men Can Rewind 2,000 Armatures per Month

THIS article deals with the organizing of armature rewinding procedure on the basis of a complete service in which an exchange stock of small armatures, quick delivery and careful supervision of rewinding work in departmentized groups has resulted in a large volume of repair work. The practices followed were originated to take care of armatures used with automobile starting and lighting equipment, but have been found to be well adapted to handling large numbers of fractional horsepower armatures received from industrial plants and other sources.

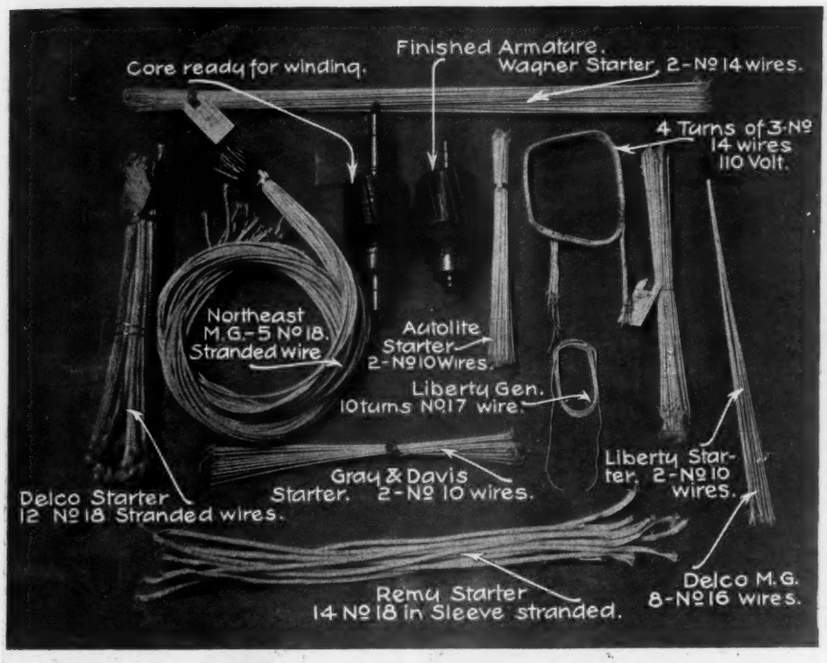
Every armature received by mail, express or messenger, enters the shop through a combined receiving and shipping room. Here it is unpacked and an identification record made out and attached to it. It is then placed in a compartment of an open-back, shelved partition in the receiving room. An order clerk at this point makes out the proper shop order and records for identification and billing.

IDEAL CONDITIONS in a repair shop where large numbers of armatures of the same type are repaired and rewound include orderly routine, standardization of methods and an experienced force of winders who not only know the details of the work assigned to them, but appreciate that speed and quality of workmanship are interrelated. This article gives the order of procedure in handling a rewinding job, as organized to approach such conditions as nearly as possible, and carried out by the armature repair division of the United States Auto Supply Company, Chicago, Ill., where something like 2,000 small armatures are rewound each month.

About 5,000 repaired armatures are stored in these racks ready to be shipped out as exchanges.

If an armature is to be returned to the sender, a number is stamped on the core by the order clerk. If an exchange armature is to be forwarded this identification number is not required. The order clerk places the armatures for which he has made out shop orders into a second set of open-back shelved partitions separating the receiving and shipping departments from the shop proper.

Stripping the old armature is the first shop operation. This is followed by cleaning, insulating, winding, varnishing, commutator turning and testing in organized departments. The stripping operation is started on the main shop floor. Here the armature is mounted in a speed lathe and the leads cut off just back of the


Core ready for winding.
Finished Armature.
Wagner Starter, 2-№14 wires.
4 Turns of 3-№ 14 wires 110 Volt.
Northeast M.G.-5 №18. Stranded wire
Autolite Starter 2-№10 Wires.
Liberty Gen. 10turns №17 wire.
Liberty Starter, 2-№10 wires.
Gray & Davis Starter. 2-№ 10 wires.
Delco Starter 12 №18 Stranded wires.
Delco M.G. 8-№16 wires.
Remy Starter 14 №18 in Sleeve stranded.

Stock units are supplied to armature winders in these forms for the different types of cores.

The bundles of wires shown represent single coils and groups of single coils prepared for specific jobs. Two formed coils are shown for use on certain types of armatures. With the wires cut to length there is no chance for a winder to put the wrong number of turns in any coil. The core with the package of insulation attached is ready for the winder, while the armature beside the core is ready for stock or shipment.

commutator by means of a cut-off tool with a V-shaped point. In case the armature winding has been impregnated so that the coils are solid, two other cuts are made, one at each end of the core. These two cuts remove all of the winding except that portion of the coils inside the slots. After the cutting-off operation the armature is sent up to a balcony by means of a small, hand-operated elevator alongside of the speed lathe.

Windings that have not been solidly impregnated are stripped off by the aid of a special device that removes the old wire and winds it up in small balls. This device is essentially a power-driven spindle. One end projects a few inches beyond the bearing and is slotted. The end of the outside coil cut free from the commutator is inserted in the slot of the spindle and as this revolves it pulls off and winds up the wire forming the outside coil. The ends of the other coils are taken off one at a time until all are removed. The wire forming each coil is easily slipped off the tapered unwinding spindle before the next coil is wound. A foot-operated start-and-stop clutch is used.

In the case of the impregnated windings that have been cut at each end of the core the parts of the coils remaining in the slots are driven out with properly shaped drifts.

This is the beginning and end of the armature repair circuit—a combined receiving and shipping room.

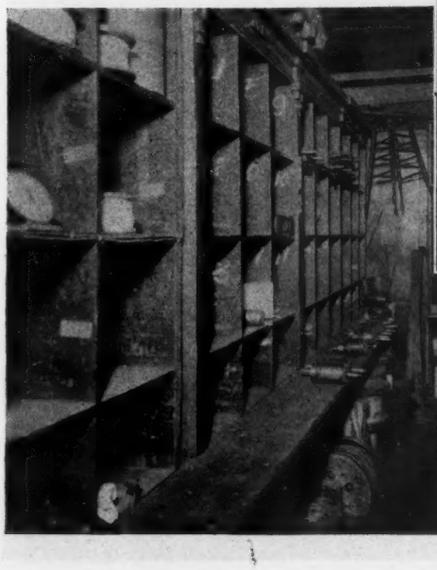
When the armatures are unpacked they are placed with a slip of paper bearing the sender's name and address and any comments or instructions, in the compartments in front of the counter. The order clerk takes the armatures with these instructions from the back of the compartments.

Insulation Is Prepared in a Separate Department

After the windings are removed, the cores are immersed in a tub of varnish remover (made by the Standard Varnish Works) to clean off all varnish and foreign matter. The

This open-back shelved partition separates the stock room from the repair shop.

The order clerk places jobs ready for the shop together with the shop copy of the order in these compartments. Since the compartments are open, the work is put in on one side and drawn out on the other.

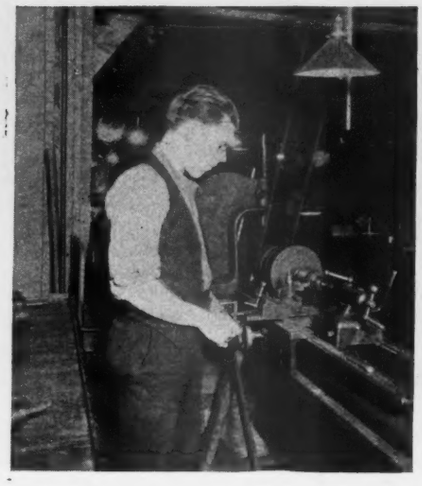


Here the order clerk is making out a shop order for repairing an armature.

Shop orders are made in triplicate. The original is placed on the file board above the clerk's desk and used as a shipping ticket. One copy goes to the office file and the other goes with the armature to the shop.

Ten Steps in Armature Winding Procedure

This is the starting point of an armature for repair in the shop.
The workman is drawing an armature from the shop side of the rack separating the stock room from the shop. The shop order which accompanies it goes to the foreman's desk, while the armature goes to the lathe where the coil connections are cut free from the commutator.

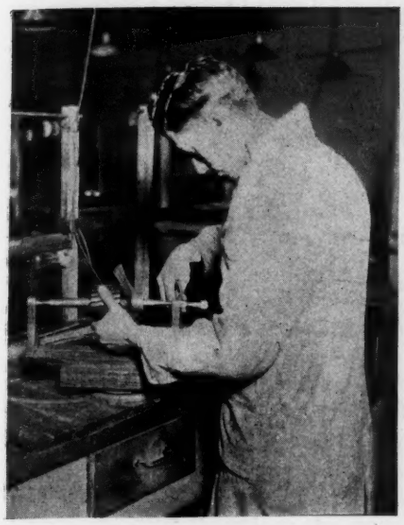


This is the first repair step. The operator is cutting the connections back of the commutator.
The tool used has a sharp V-shaped point. In case the coils are impregnated and baked hard, two additional cuts, one at each end of the core, are made while the armature is in this lathe. When the two ends of the coils are cut off in this manner the remaining portions are driven out of the slots. Otherwise the coils are unwound by a special tool.

This is a quick way to unwind a coil of many turns from the slots of an armature.
The end of the coil, cut free from the commutator, is drawn into a slot in the end of the unwinding spindle. This spindle is driven by a belt and controlled by a foot-operated clutch. With the wire drawn into the slot, the clutch is closed and the spindle rotates and unwinds the coil. The armature vibrates between the centers as the coil comes off.

Driving out sections of impregnated coils from core slots.
The coils are previously cut off at each end of the core. Drifts of suitable size are used to drive out the portion of the coils within the slots. The armature is mounted between centers for convenience.

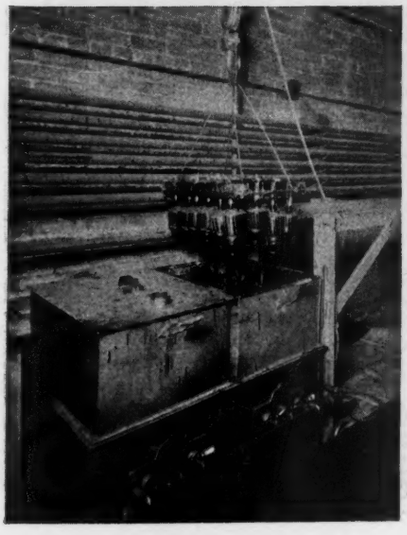
Insulating armature cores after stripping and cleaning.
The workman in the foreground is "strip" insulating an armature. The insulation comes off a roll mounted beneath the bench. The shear operator is cutting up sheet insulation into small pieces suitable for individual-slot insulation. The hand press at the right is used for putting on new commutators.



This shows the winder's bench and how he mounts the prepared core in centers for convenience in winding the coils.
Cores received by the winders have been stripped and cleaned and have had the commutators slotted. When "strip" insulation is not used, a package of insulation is attached to core.

In soldering leads of the armature coils to the commutator wire solder is employed.
A gas blow pipe permanently attached to a standard is used to supply the heat. The flame plays directly on the outer ends of the commutator bars while solder is applied to the terminals in the slots. This method of heating insures a sufficiently high temperature in both the bottom and top of the slot.

The winder is shown above testing out a completed armature at the bench as a check on his work.
A 110-volt testing circuit with a lamp in series is provided at each winding bench. The winder frequently tests his work for grounds and thus has some assurance that the job is in good condition when completed. Each armature is given a final test by an inspector who passes on the quality of the work.

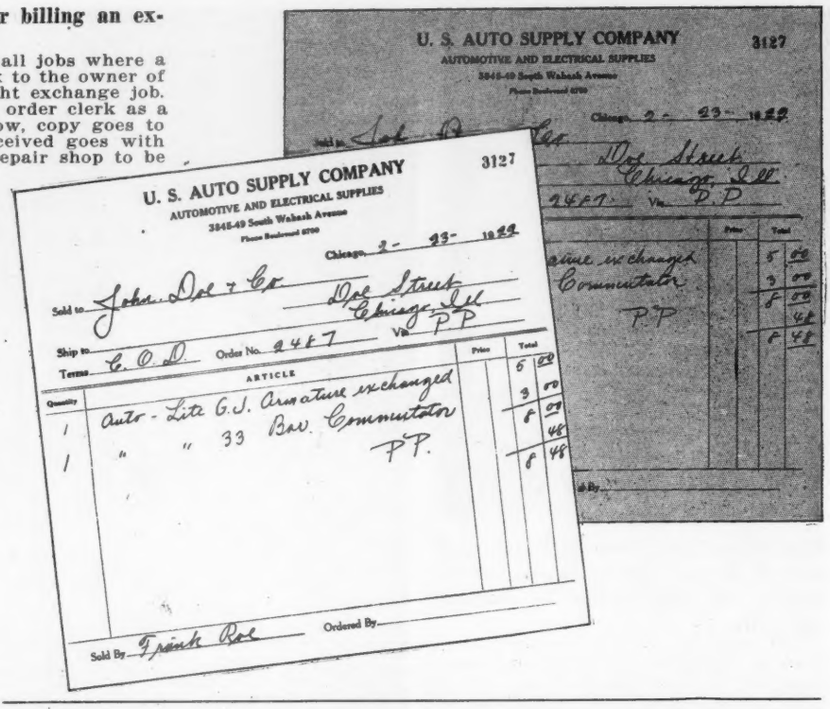


This varnish tank and rack provide for dipping thirty-six armatures at one time.
All armatures are dried at a temperature of about 150 deg. F., for approximately 30 min. in the oven at the left of the varnish tank before being dipped. The varnish is maintained at about 100 deg. F. The armatures stay in the varnish for 10 to 15 min. and are allowed to drip for 45 min.

This is the last shop operation on a repair job—the undercutting of mica and testing the winding.
After the commutators are turned down the mica is undercut with a saw about ½ in. in diameter attached to the shaft of a small motor. The device for holding and undercutting may be seen just beyond the test equipment. Each armature is tested before receiving final shop approval for shipment.

Order and record form for file and for billing an exchange job.

This form is made out in duplicate for all jobs where a repaired armature is returned from stock to the owner of the armature received. This is a straight exchange job. The first, or white, copy is used by the order clerk as a shipping ticket, and the second, or yellow, copy goes to the office to be filed. The armature received goes with others of a similar character into the repair shop to be repaired and placed in stock.



cores are then placed on a table in the center of the balcony, where they are convenient to the insulating department. In this department complete sets of insulation are cut from 24 in. by 36 in. sheets by the aid of a large hand-operated shear and are wired fast to the armature shaft. The sheet insulation used consists of a combination of 0.004 in. fishpaper and 0.006 in. empire cloth glued together, the two pieces forming a sheet just a little over 0.010 in. thick.

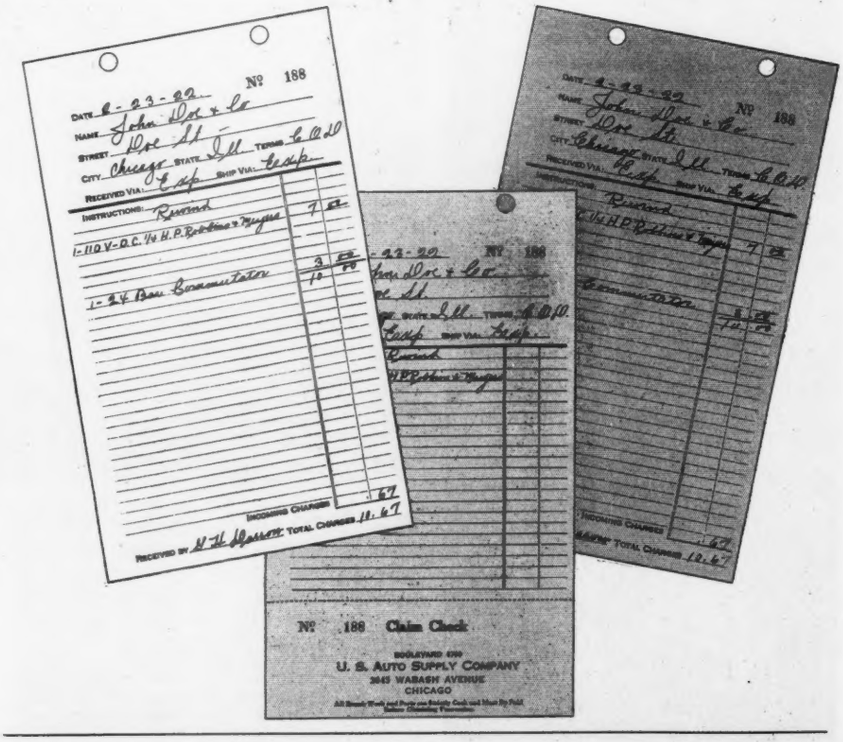
In addition to the sheets of combination insulation and rolls of strip insulation, rolls of 0.005 and 0.008 in. fishpaper and 0.008 in. red fiber are carried in stock. Certain types of armatures are strip insulated, and these have the insulation put into the slots in the insulating department. Red fiber strip insulation is purchased in rolls 12 in. to 15 in. in diameter and 2⅞ in. wide.

A hand press installed in the insulating department is used to press on commutators and do other similar tasks when required. A milling machine is used to slot the commutators. Armatures with the sets of insulation attached and with the commutators properly slotted, are carried down to the main floor and placed in a rack on the aisle near the winding benches. The foreman then turns them over to the armature winders.

The core assigned to a winder is removed from the rack and taken to the bench where it is mounted between centers on a rack such as shown on page 123. This rack rotates about a vertical spindle in the top of the bench. Along with the core the winder is given a drawing showing the mechanical and electrical details of the job which he is to do. These drawings are backed up with 5 in. by 8 in. cardboard and faced with celluloid for protection. Each drawing shows the style of winding, the size of wire and number of turns per coil, the type of winding, the commutator connections and the limiting dimensions. It also shows the core and shaft dimensions so that a check may be made to be sure that everything is correct. These drawings are kept in a card-filing case on

Shop order and records for identification and billing.

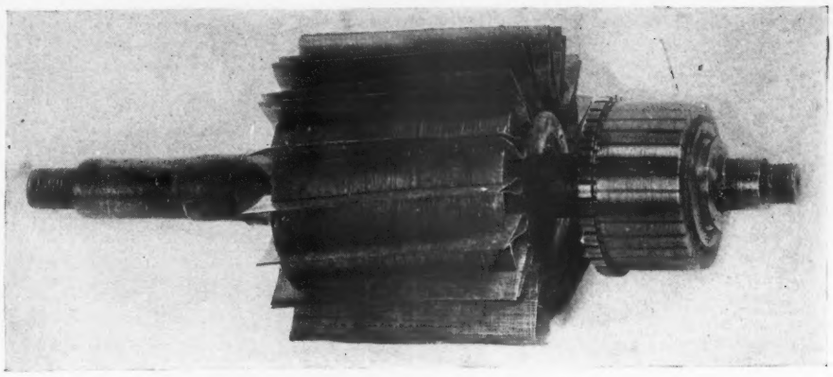
This form is made out in triplicate and used for all jobs that require the return to the original owner of the parts received; that is, on all non-exchange jobs. The number (No. 188 on this set of blanks) is stamped on the armature core by the order clerk. The first or white copy is retained by the order clerk until the finished job is returned to him for shipment to the customer. The second, or pink, copy is sent to the main office file for permanent record. The numbered slip attached to the bottom of the pink copy is torn off and pinned to the third or cardboard copy of the order which goes with the work into the shop. The pink slip is retained by the shop superintendent as a check on the work in hand. The shop copy is kept at the foreman's desk and is used to enter a record of the work done in case more or less is required than that shown by the entries made by the order clerk. When the armature with the shop copy of the order returns to the order clerk he corrects his white copy and then uses it as a shipping order. The clerk forwards the shop copy to the office, where it is filed with the pink copy already in the office file. All charges are entered on the slips by the order clerk from a list of fixed costs for each piece of work.



the foreman's desk as shown on this page. A drawing is filed for each style of winding. New drawings are made as new jobs come into the shop so that the data system is always ready to meet the needs of the winders without delay.

Wire is Supplied to Winders in Bundles or Small Coils

Wire ranging in size from No. 40 to No. 8 is supplied to the winders from the stock room in reels of about ten pounds each. The larger reels on which the wire is received are broken up into the smaller units in the stock room. This rereeling of the wire provides the winder with a unit much easier to handle and also reduces by eighty per cent the quantity of wire required at the benches to provide for the work in hand. Many types of windings require the use of several (2 to 14) wires in parallel, and in such cases wires made up in bundles instead of wound on reels, are provided. These bundles are made up in sets suitable for a single job. In some cases the insulation is stripped off at one end to facilitate the work.

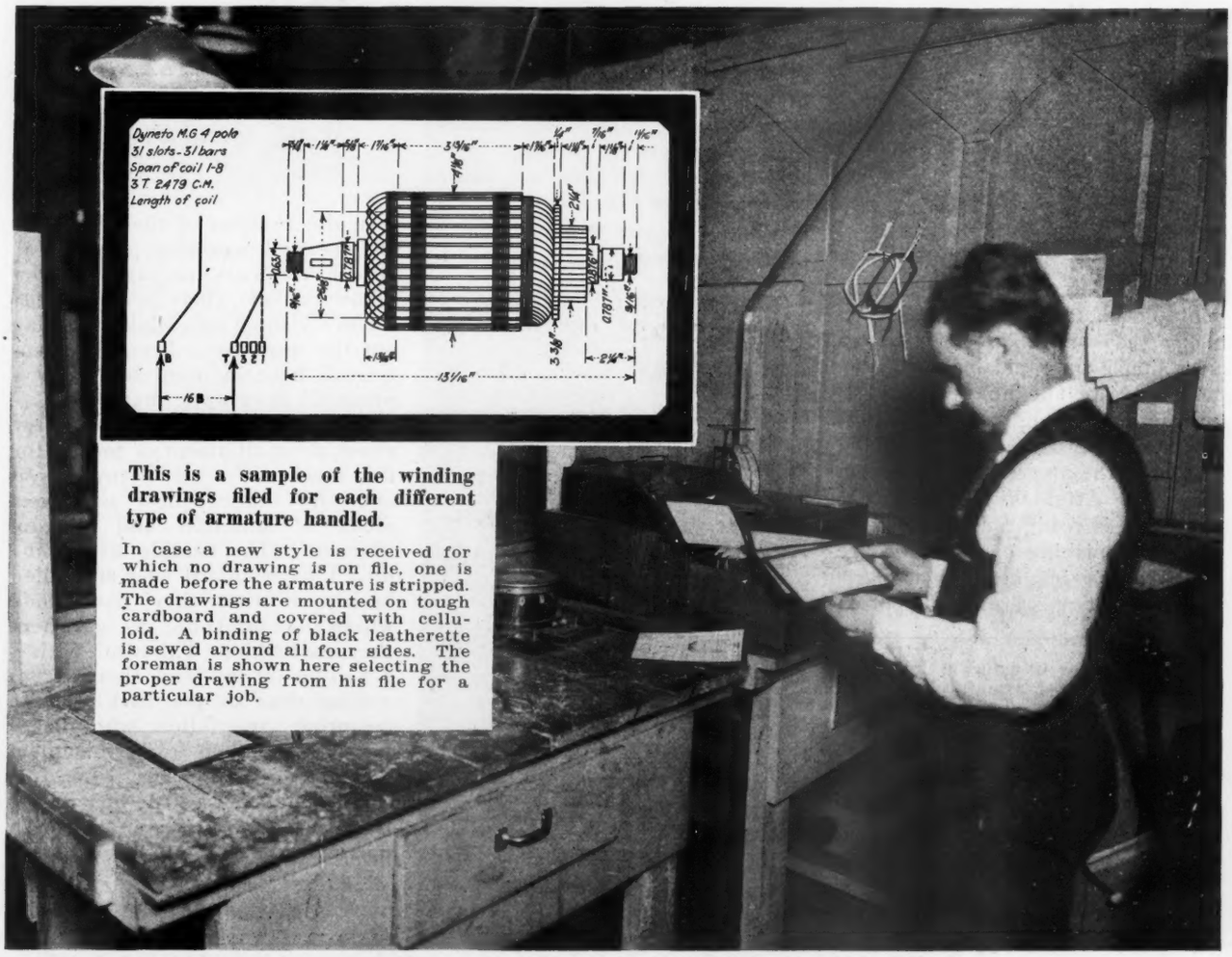


For slots with small openings separate slot insulation is used.

Slot insulation of this type is cut about ¼ in. longer than the armature slot and wide enough to allow the two edges to extend from ½ to ¾ in. out of the slot. As a rule the insulating material is put into the slots as the coils are started. Thus there would be only two slots insulated when the first coil is being wound, and the last slot would not be insulated until just before a coil is started in it.

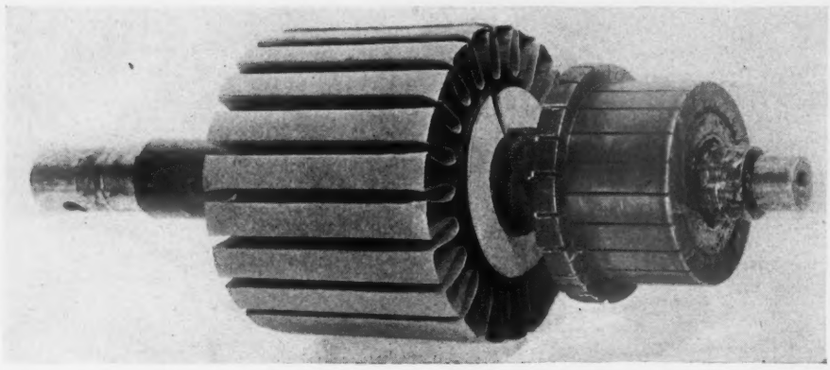
Each winder has a set of 110-volt test leads with a lamp in series attached to his bench so that he can test out each coil as the work progresses. The windings are applied by hand with the armature mounted in the centers already mentioned, and when complete the workman gives the job a preliminary test for grounds and short circuits.

Armatures that require a large number of turns per coil, say 50 to 100 or more, are wound on a special Chapman winding machine, shown on page 126. This machine is motor driven and is started and stopped by a foot-operated lever. A large hand wheel on the winding shaft serves



This is a sample of the winding drawings filed for each different type of armature handled.

In case a new style is received for which no drawing is on file, one is made before the armature is stripped. The drawings are mounted on tough cardboard and covered with celluloid. A binding of black leatherette is sewed around all four sides. The foreman is shown here selecting the proper drawing from his file for a particular job.



This is the way an armature core looks when strip-insulation is used.
This type of insulation is applied in a long strip about ¼ in. wider than the core. The strip is pushed down into each slot and creased over the tops of the teeth. After the coils are all in place the insulation is cut along the top of the teeth and folded down over the coils. Slot sticks or wedges are then inserted over the folded-down insulation.

in the double capacity of a brake and a hand motion for making a final turn or part of a turn after stopping the machine. Various sets of jaws are provided to grip armatures of different sizes and shapes. A counter attached to the machine indicates the number of turns made so that the operator can see at all times just how far the winding of each coil has progressed.

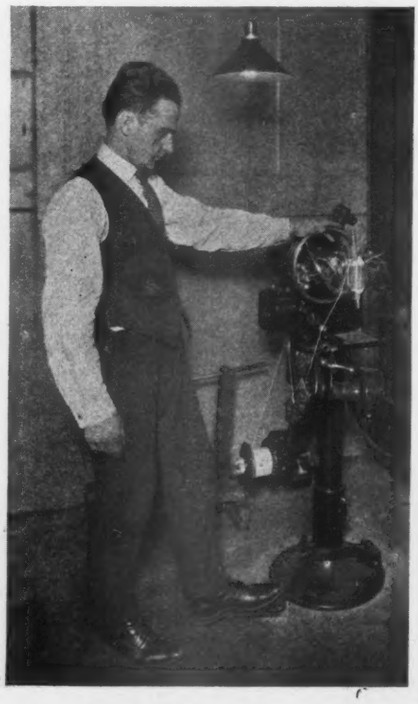
This winding machine is so constructed as to hold the core by actually gripping it rather than by suspending it from centers holding the ends of the shaft. Special wire guides are provided to prevent fouling and damaging the insulation when doing a job with the commutator in place.

When the winding is in place and connected to the commutator the work passes on to the solderer. Soldering is done with the aid of a fixed gas blow torch and wire solder. The armature is supported with the commutator under the torch flame and the wire solder melted into the commutator slots by the heat conducted along the bars. This operation is very simple and rapid and the method of applying the heat insures the proper heating of the entire slot. The next operation consists of binding down the connections at the commutator. After this operation the armature is ready for varnishing.

The varnishing operation is preceded by drying out for about 30 min. at a temperature of approximately 150 deg. F. Six "sticks" of six armatures each are suspended at a time on a frame in gas-heated drying ovens. The frame is then lifted out and with the attached thirty-six armatures lowered into a bath of "Standard" insulating varnish maintained at a temperature of 100 deg. F. After soaking for 10 to 15 minutes the frame is hoisted out and allowed to drip for 45 minutes over the varnish bath. The "sticks" of armatures are then removed and placed in the baking ovens where they are allowed to remain over night.

Baked armatures removed from the ovens in the morning are finished by having the commutator turned, the mica undercut, the varnish spun from the shaft and the final tests for grounds, short circuits and open circuits applied. The method of spinning the varnish from the shafts is unique. Two supporting arms attached to the carriage of the lathe used to turn the commutators, carry swinging arms that lower scraping blades onto the top of the shaft as the armature rests between the lathe centers. With the armature rotating these blades are lowered onto the shaft and moved along to scrape or spin off all the varnish.

The finished units are passed back to the finished stock room where all cores having identification numbers stamped on them are packed for shipment to their owners while all others are placed in stock to be shipped out later as exchange units.



This operator is using a Chapman motor-operated armature winding machine.
An assortment of holding clamps to fit various sizes of armatures adapts this machine to a large variety of work. The machine is particularly suitable for armatures having coils with a large number of turns. In this illustration the operator has stopped the machine with a coil half wound. The turn-counting device may be seen just above the operator's left hand. The driving motor is controlled by the foot lever. The hand wheel serves as a brake and is useful in making the last one or two turns.

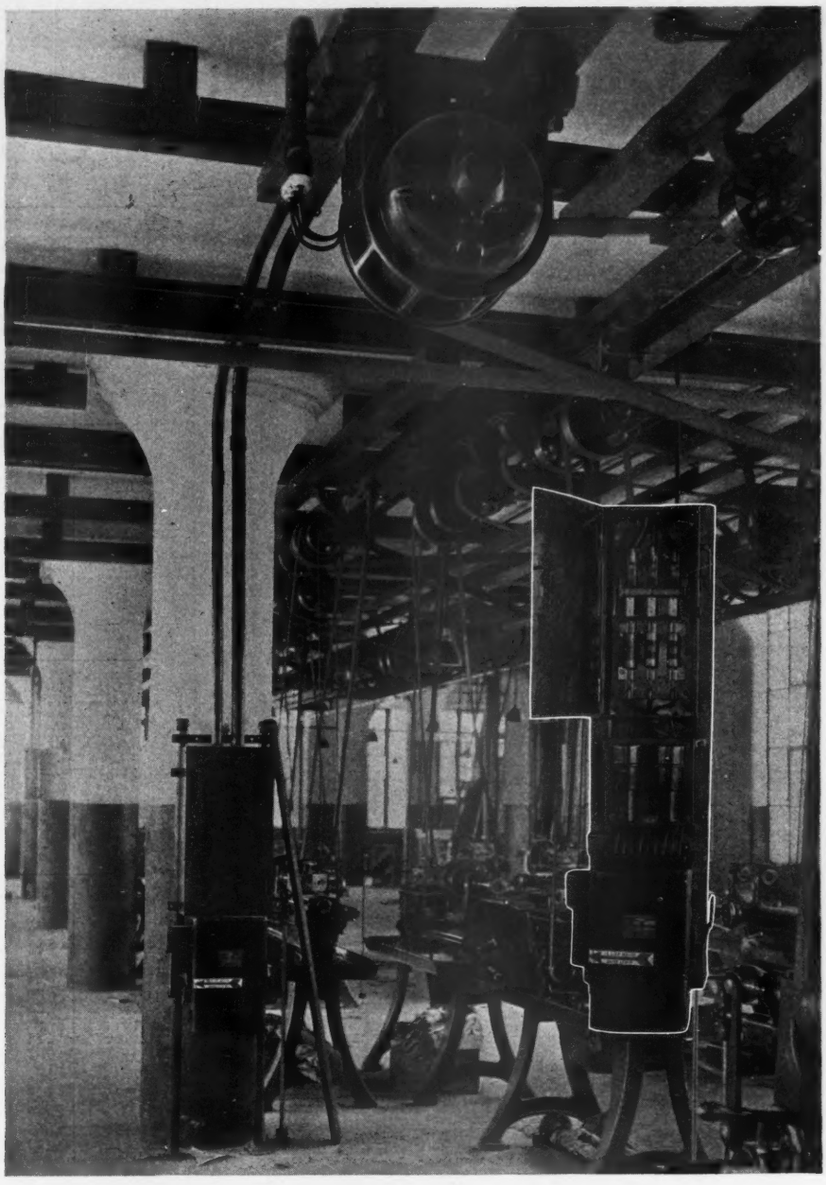
Make a Plan and Then Work That Plan

In the heading of the article on the material handling program at Studebaker Works on page 59 of the February issue, there is a real idea for every shop man who has to lay out the work for others. The sentence I have in mind is, "Make a plan and then work that plan."

Most men don't need to worry about their allotment of brains, for the main difference between you and the other fellow who gets along is ambition and stick-to-itiveness. The trouble with some men I have known who are called brainy, is that they don't look where they are going, nor go where they are looking. The result is they get so far off the track that it takes a long time to get back. In the meantime, the fellow who makes his plan and then works that plan, gets to the place he heads for. Just think about this a little bit and see if you are headed for any place in particular.

Practical Pete

H. L. CORNELISON has packed into this article the data which must usually be gathered from several places. He tells how to find the size of wires, fuses, switches and conduit for motors and gives this information in convenient tables. He takes up some important points in running circuits for motors doing special duty under conditions that call for slow and variable speeds, starting under heavy loads or driving machines under special conditions.



Information That You Need

When Wiring for Motors

in Ordinary and Special Service

By H. L. CORNELISON

Electrical Engineer, The Austin Company, Industrial Consulting Engineers, Cleveland, Ohio.

WHEN deciding on size of fuses, switches and wiring to use for a certain size of motor, it is often found that the information and data needed for different motor ratings must be obtained from several sources and much time is often required to get it together. The accompanying series of tables has been compiled to save time when this information is needed.

These tables give the practical information it is necessary to know when wiring for standard motors, either direct-current or three-phase alternating-current, and for any voltage from 110 to 2,200. In a later issue other tables will be published covering single-phase and two-phase motors. The tables apply to 40 deg. motors under ordinary operating conditions. Of course, they do not cover extraordinary cases or special designs of machines which are made for severe operating conditions. Furthermore, as every electrical man will probably understand, the sizes of wire and fuses given in the tables apply to circuits feeding only one motor. A method of figuring the size to use when circuits feed more than one motor will be discussed somewhat in detail with examples, later in the article.

Although the tables specify one particular voltage, they apply to a voltage range 10 per cent above or below the value given. The current values shown are averages of several makes of motors. In some cases motors of a particular manufacture have been used, and such a fact is indicated in the table. Standard speeds are considered in all cases. The tables do not consider voltage drop, but if the line is very long, the voltage drop may be so great that the motor will not operate at high efficiency. Later on the article tells how to find out whether a larger wire should be used on account of the voltage drop.

How to Find Size of Wiring, Switches and Fuses

When wiring for a motor, first find the table which applies to the kind of motor and the voltage range in which that particular motor rating falls.

Then to the right, under the proper heading, you will find the size of wire, switches, fuses and conduit. The size of the running fuse is large enough to allow 25 per cent overload on the motor. Where a standard size of fuse does not exactly correspond with 25 per cent overload, the next

Wiring Data on Direct and Alternating Current Motor Circuits

DIRECT-CURRENT MOTORS, 110 VOLTS

H.P.	Approx. Full-Load Current, Amp.	Size of Wire, B. & S. Gage	Size of Switch, Amp.	Size of Fuse, Amp.	Conduit Size, In.
¼	2.5	14	30	6	½
½	4.4	14	30	10	½
1	9	14	30	12	½
2	17.0	10	30	25	¾
3	24	8	30	30	¾
5	39	6	60	50	1
7½	58	4	100	75	1¼
10	75	1	100	95	1¼
15	113	00	200	150	2
20	150	000	200	200	2
25	191	250,000	400	250	2½
30	226	250,000	400	300	2½
35	264	500,000	400	350	3
40	300	500,000	400	400	3
50	375	700,000	600	*500	3½
55	413	800,000	600	*550	3½
65	488	900,000	*800	*610	3½
70	525	1,100,000	*800	*656	4
75	562	1,200,000	*800	*702	4½

DIRECT-CURRENT MOTORS, 220 VOLTS

H.P.	Approx. Full-Load Current, Amp.	Size of Wire, B. & S. Gage	Size of Switch, Amp.	Size of Fuse, Amp.	Conduit Size, In.
¼	1.3	14	30	6	½
½	2.3	14	30	10	½
1	5	14	30	10	½
2	9	14	30	12	½
3	12	14	30	15	½
5	19.0	10	30	25	¾
7½	29	6	60	40	1
10	38	6	60	50	1
15	56	4	100	70	1¼
20	74	1	100	95	1½
25	93	0	200	120	1½
30	111	00	200	150	2
35	130	000	200	175	2
40	148	200,000	200	200	2
50	184	300,000	400	250	2½
55	202	300,000	400	275	2½
60	221	300,000	400	275	3
65	240	500,000	400	300	3
70	258	500,000	400	325	3
75	276	500,000	400	350	3
80	294	500,000	400	375	3
85	312	500,000	400	400	3
90	331	600,000	600	450	3
100	368	700,000	600	500	3½

DIRECT-CURRENT MOTORS, 550 VOLTS

H.P.	Approx. Full-Load Current, Amp.	Size of Wire, B. & S. Gage	Size of Switch, Amp.	Size of Fuse, Amp.	Conduit Size, In.
¼	0.52	14	30	3	½
½	0.94	14	30	3	½
1	2	14	30	5	½
2	4	14	30	6	½
3	6	14	30	10	½
5	9	14	30	12	½
7½	12	14	30	15	½
10	16	12	30	20	¾
15	24	8	30	30	1
20	31	6	60	40	1
25	39	6	60	50	1
30	46	4	60	60	1¼
35	54	4	100	70	1¼
40	62	2	100	80	1¼
50	77	1	100	100	1½
55	84	0	200	110	1½
60	92	0	200	125	1½
65	100	0	200	125	1½
70	107	00	200	150	2
75	115	000	200	150	2
80	122	000	200	175	2
85	130	000	200	175	2
90	138	000	200	175	2
100	153	200,000	200	200	2

SQUIRREL-CAGE INDUCTION MOTORS—THREE-PHASE, 110 VOLTS

H. P.	Approx. Full-Load Current, Amp.	Size of Wire, B. & S. Gage	Size of Switch, Amp.	Size of Starting Fuses, Amp.	Size of Running Fuses, Amp.	Conduit Size, In.
1	6	14	30	20	10	½
2	12	10	60	35	15	¾
3	18	8	60	50	25	1
5	27	6	100	70	35	1¼
7½	40	4	100	80	50	1¼
10	52	2	200	110	65	1½
15	76	1	200	150	100	1½
20	100	1	200	200	125	2
25	125	000	400	250	175	2
30	150	200,000	400	300	200	2½
35	175	300,000	400	350	225	2½
40	200	300,000	400	400	250	2½
50	240	400,000	*600	500	300	3

SQUIRREL-CAGE INDUCTION MOTORS—THREE-PHASE, 220 VOLTS

H. P.	Approx. Full-Load Current, Amp.	Size of Wire, B. & S. Gage	Size of Switch, Amp.	Size of Starting Fuses, Amp.	Size of Running Fuses, Amp.	Conduit Size, In.
1	3	14	30	10	10	½
2	6	14	30	20	10	½
3	9	10	30	30	12	¾
5	14	8	60	40	20	1
7½	20	8	60	50	25	1
10	26	6	100	65	35	1¼
15	38	4	100	90	50	1¼
20	50	2	200	110	65	1½
25	63	2	200	125	80	1½
30	75	1	200	150	95	1½
35	87	0	200	175	110	2
40	100	0	200	200	125	2
50	125	000	400	250	175	2
75	186	300,000	400	375	250	2½
100	245	400,000	600	500	325	3
150	365	700,000	800	*730	450	3½
200	480	1,000,000	1,000	*960	600	4

SQUIRREL-CAGE INDUCTION MOTORS—THREE-PHASE, 440 VOLTS

H. P.	Approx. Full-Load Current, Amp.	Size of Wire, B. & S. Gage	Size of Switch, Amp.	Size of Starting Fuses, Amp.	Size of Running Fuses, Amp.	Conduit Size, In.
1	2	14	30	6	3	½
2	3	14	30	10	4	½
3	5	14	30	15	7	½
5	7	14	30	25	10	½
7½	10	12	30	25	15	¾
10	13	10	30	30	20	¾
15	19	8	60	50	25	1
20	25	6	100	70	35	1¼
25	32	6	100	75	40	1¼
30	38	4	100	90	50	1¼
35	44	4	100	100	55	1¼
40	50	2	200	110	70	1½
50	63	2	200	125	80	1½
75	93	0	200	200	120	2
100	122	000	400	250	175	2
150	182	300,000	400	375	225	2½
200	240	400,000	*600	*500	300	3

*When fuse sizes exceed 600 amp. circuit breakers of approved type must be substituted.

To obtain running fuse for 50 deg. motor, divide full load current by 1.32 and use nearest commercial size.

SQUIRREL-CAGE INDUCTION MOTORS THREE-PHASE, 550 VOLTS, 60 CYCLES

H. P.	Approx. Full-Load Current, Amp.	Size of Wire, B. & S. Gage	Size of Switch, Amp.	Size of Starting Fuses, Amp.	Size of Running Fuses, Amp.	Conduit Size, Inches
1	1.5	14	30	5	3	½
2	2.4	14	30	10	4	½
3	4	14	30	15	6	½
5	5.6	14	30	20	8	½
7½	8	14	30	20	10	½
10	10	12	30	25	15	¾
15	15	10	60	35	20	¾
20	20	10	60	50	25	¾
25	25	8	60	60	35	1
30	30	6	100	70	40	1¼
35	36	6	100	75	45	1¼
40	40	6	100	80	50	1¼
50	50	4	100	100	65	1¼
75	75	1	200	150	95	1½
100	98	0	200	200	125	2
150	146	200,000	400	300	200	2½
200	192	250,000	400	400	250	2½

SQUIRREL-CAGE INDUCTION MOTORS THREE-PHASE, 2,200 VOLTS, 60 CYCLES

H. P.	Approx. Full-Load, Current, Amp.	Size of Wire, B. & S. Gage	Size of Switch, Amp.	Size of Starting Protection, Amp.	Size of Running Protection, Amp.
15	3.8	14	60	10	5
20	5.6	14	60	15	7
25	6.3	14	60	20	8
35	9.3	12	60	25	12
40	10.3	12	60	30	13
50	12.5	10	60	35	16
60	14.5	10	60	40	18
75	18.5	8	60	50	23
100	24.5	6	60	65	31
150	37.5	6	60	75	47
200	48.6	4	200	100	61
250	61.0	2	200	120	77
300	73.0	1	200	150	92
400	99.0	0	200	200	120
450	112.0	00	200	225	140
500	122.0	00	200	250	150
600	146.0	000	200	300	180
750	184.0	300,000	200	375	230

larger size of fuse is given. The size of wire which will carry the current corresponding to the fuse rating is given in one column, and the standard size of switch large enough to carry this current is in another column. In the column to the extreme right is found the size of conduit required for the wiring to the motor.

In the case of alternating-current motors, it is necessary to install starting fuses large enough to carry the starting current of the motor. Therefore the size of the wire and the switches must be large enough to correspond to the rating of the starting fuse.

For motors which take less than 30 amp. on full load, the starting current is figured as 250 per cent of full load, and for those which take over 30 amp. the starting current is 200 per cent of full-load current. In the case of some small motors the starting current will be even higher than these values. When small motors are thrown directly on the line the starting current may safely be taken as about 300 per cent of the full-load current.

Standard fuses may be used when the current is not over 600 amp., but above this value circuit breakers of approved type must be employed. As you will notice, when the currents are above 600 amp. the exact figures are given instead of the nearest fuse ratings. For 2,200-volt motors, oil switches must be substituted in the place of ordinary knife-blade switches.

For motors rated on a 50-deg. temperature rise, the size of fuses and wire should not be rated more than 110 per cent of full-load current. In calculating the wire sizes for use with alternating-current motors advantage is taken of the ruling of the National Electrical Code, which permits rubber-covered wires to carry the same current as wire with other insulations, provided the circuit feeds only one motor. This rule means, for instance, that if a motor takes 200 amp. on starting, No. 0 wire may be used, as shown by Table C of the National Electrical Code, instead of 200,000 circ. mils. as shown by Table A.

Switches, Cut-outs, Circuit Breakers and Auto-Starter

Each motor and its starting device must be protected by a cut-out, and this should be controlled by a switch located near the motor. An automatic circuit breaker which disconnects all wires may serve as a switch. The

WIRE TABLE—Information on Weight, Resistance, Allowable Current and Conduit Sizes

Size No. B. & S.	Area of Section (Bare)		Pounds per 1,000 Ft.					Ohms per 1,000 Ft.	Amp. Allowed, N. E. C.			*Size of Conduit Required for Double-Braid Rubber-Covered Wire			
												Number of Wires			
	Circ. Mils.	Sq. In.	Bare	Triple-Braid W. P.	Double Braid R. C.	3,000-Volt Varn. Camb.	3-Con. Lead-Covered Cable		Rubber-Covered	Varnished Cambric	Other Insulation	1	2	3	4
14	4,107	0.003227	12.4	25	57			2.527	15		20	½	½	½	¾
12	6,530	0.005127	20	35	48			1.589	20		25	½	¾	¾	¾
10	10,382	0.00816	31	53	64			0.9995	25		30	½	¾	¾	1
8	16,510	0.01298	50	75	86			0.6285	35		50	½	1	1	1
6	26,250	0.02063	79	112	135	228	1803	0.3953	50	60	70	½	1	1¼	1¼
5	33,102	0.02617	100		170			0.3135	55		80	¾	1¼	1¼	1¼
4	41,743	0.02380	126	164	227	301	2159	0.2486	70	85	90	¾	1¼	1¼	1½
3	52,634	0.04135	160		272			0.1971	80		100	¾	1¼	1½	1½
2	66,373	0.05214	201	260	329	416	2955	0.1563	90	110	125	¾	1¼	1½	1½
1	83,695	0.0658	253	316	417	495	3290	0.1240	100	120	150	¾	1½	1½	2
1/0	105,593	0.0829	320	407	526	570	3725	0.0983	125	150	200	1	1½	2	2
2/0	133,079	0.1045	403	502	647	676	4206	0.0780	150	180	225	1	2	2	2½
3/0	167,805	0.1475	508	629	782	818	5184	0.0618	175	210	275	1	2	2	2½
	200,000	0.1611	599	729	898	946	5726	0.0531	200	240	300	1¼	2	2½	2½
4/0	211,600	0.1662	641	767	942	994	5928	0.0490	225	270	325	1¼	2	2½	2½
	250,000	0.1694	755	985	1103	1124	6805	0.04203	250	300	360	1¼	2½	2½	3
	300,000	0.2356	918	1174	1285	1319	8169	0.03502	275	330	400	1¼	2½	3	3
	400,000	0.3142	1210	1553	1650	1639	9692	0.02627	325	390	500	1¼	3	3	3½
	500,000	0.3927	1514	1894	2010	1996	11288	0.02101	400	480	600	1½	3	3	3½
	600,000	0.4712	1817	2235	2418	2359		0.01751	450	540	680	1½	3	3½	3½
	700,000	0.5498	2121	2650	2880	2639		0.01501	500	600	760	2	3½	3½	3½
	750,000	0.5890	2272	2822		2811		0.01401	525	630	800	2	3½	3½	4
	800,000	0.6283	2423	2992	3138	2986		0.01313	550	660	840	2	3½	4	4
	900,000	0.7069	2741	3332	3491	3330		0.01167	600	720	920	2	3½	4	4
	1,000,000	0.7854	3030	3674	3849	3678		0.01051	650	780	1000	2	4	4	5

*Size of conduit refers to runs having not over three 90-deg. elbows for sizes up to No. 10, and not over two 90-deg. elbows for larger sizes.

switch itself may be omitted for an alternating-current motor, provided that the starting device disconnects all wires of the circuit and also that it is not an auto-starter (compensator). The fuse or the circuit breaker may be omitted from the circuit of direct-current starters if the overload device on the starter operates during both starting and running of the motor. In case of an alternating-current starter the running fuse may be omitted if the overload device operates when the starter is in the running position.

Size of Wire to Use when More Than One Motor Is Fed From a Circuit

When more than one motor is connected to a circuit, the heaviest load which will be on the circuit at any one time must be determined and the wire size selected for that load. Under usual conditions, the total amount of current drawn by a group of motors is usually less than the sum of the full loads of all the motors added together. However, if you have no good reason for thinking that the current will be less than the sum of all full loads, it is safer to figure that all of the motors will be drawing their full-load current. In any method of calculating the total current, do not forget to include the starting current of the largest motor instead of its running current. To explain this the following example is given:

To Find the Size of Mains for Direct-Current Motors

Suppose that you have three 110-volt direct-current motors rated at 10 hp., 15 hp. and 20 hp., respectively. As you are unable to measure the load which will occur on the main line feeding these motors, you may assume that the rated full load will be the heaviest load. The following table will show how the total current will be calculated. The full-load currents shown are taken from the table for 110-volt motors:

	Amp.
10-hp. motor (110 volts) has full-load current of	75
15-hp. motor (110 volts) has full-load current of	113
20-hp. motor (110 volts) has full-load current of 150 amp. Multiplying this by 1.25 per cent gives	187.5
Add them for a total of	375.5

This means that the mains must be large enough to carry 375 amp. Consulting the table showing various data on wire, it is found that a 500,000-circ. mil rubber-covered wire will carry 400 amp., and this size must be used.

On a Long Run the Voltage Drop May Require a Larger Conductor

The size of conductor (500,000 cir. mil) will be plenty large enough to carry the current without overheating, but if the main is very long the voltage drop may be too great. For instance, if it is a 200-ft. run, the resistance will be equal to that in 400 ft. of 500,000-circ. mil wire, which is found by consulting the table to be (0.4×0.02101) or 0.008404 ohm. This resistance multiplied by 375 amp. gives about 3.14 volts drop. In this case this drop is present only at starting and therefore should not be objectionable.

The following paragraphs will tell how to figure the size of wire that should be used for any length of circuit to give a certain voltage drop.

How to Figure for Voltage Drop on Direct-Current Mains

When the current and the allowable voltage drop are known, the following formula may be used for finding the size of the wire:

Area in circ. mils $= (L \times 22 \times I) \div e$,

L=distance of motor (one way) in feet,

I=amperes,

e=volts drop in circuit.

Suppose, for instance, that with a current of 80 amp. at 110 volts a distance of 100 ft. there is a drop of 4 volts. Then, applying the formula:

Area $= (100 \times 22 \times 80) \div 4 = 44{,}000$.

From the wire tables, it is found that No. 4 wire is slightly less than this, and therefore No. 2 wire should be used, which gives 66,373 circ. mils. (*Continued on page* 151.)

WOUND-ROTOR INDUCTION MOTORS, THREE-PHASE (THREE-WIRE)

H. P.	Approx. Full Load, Amp.		Size Wire, B. & S. Gage		Size Switch, Amp.		Size of Protection, Amp.		Conduit Size, In.	
	220 Volts	440 Volts	220 Volts	440 Volts	220 Volts	440 Volts	220 Volts	440 Volts	220 Volts	440 Volts
1	3	2	14	14	30	30	10	10	½	½
2	6	3	14	14	30	30	10	10	½	½
3	9	5	14	14	30	30	12	10	½	½
5	14	7	12	14	30	30	20	10	¾	½
7½	20	10	10	14	30	30	25	12	¾	½
10	26	13	10	14	30	30	30	15	¾	½
15	38	19	6	10	60	30	45	25	1¼	¾
20	50	25	4	8	100	30	65	35	1¼	1
25	63	32	2	8	100	60	85	40	1¼	1
30	75	38	1	6	100	60	100	50	1½	1¼
35	87	44	0	4	200	60	110	55	2	1¼
40	100	50	0	4	200	100	125	65	2	1¼
50	125	63	000	2	200	100	175	80	2	1½
75	186	93	250,000	0	400	200	250	125	2½	2
100	245	122	400,000	000	400	200	325	175	3	2
150	365	182	600,000	0000	600	400	450	225	3½	2½
200	480	240	900,000	350,000	600	400	600	300	4	3
250	600	300	1,300,000	500,000	800	400	750	375	5	3
300	720	360	1,700,000	600,000	1000	600	900	450	5	3½

WOUND-ROTOR INDUCTION MOTORS, THREE-PHASE (THREE-WIRE)

H. P.	Approx. Full Load, Amp.		Size Wire, B. & S. Gage		Size Switch, Amp.		Size of Protection, Amp.		Conduit Size, In.	
	550 Volts	2,200 Volts	550 Volts	2,200 Volts	550 Volts	2,200 Volts	550 Volts	2,200 Volts	550 Volts	2,200 Volts
10	10	3	14	14	30	60	12	4	½	½
15	15	3.8	12	14	30	60	20	5	¾	½
20	20	5.6	10	14	30	60	25	7	¾	½
25	25	6.3	8	14	60	60	35	8	1	½
35	36	9.3	6	14	60	60	45	12	1¼	½
40	40	10.3	6	14	60	60	50	13	1¼	½
50	50	12.5	4	14	100	60	65	16	1¼	½
60	60	14.5	2	12	100	60	75	18	1½	¾
75	75	18.5	1	10	100	60	95	23	1½	¾
100	98	24.5	0	8	200	60	125	31	2	1
150	146	37.5	200,000	6	200	60	200	47	2½	1¼
200	192	48.6	250,000	4	400	200	250	61	2½	1¼
250	237	61.0	400,000	2	400	200	325	77	3	1½
300	285	73.0	500,000	1	400	200	375	92	3	1½
400		99.0		0		200		124		2
450		112.0		00		200		140		2
500		122.0		00		200		152		2
600		146.0		200,000		200		183		2½
750		184.0		250,000		200		230		2½

Does Your Organization Plan

Inspire Initiative and Responsibility

in Department Heads?

By J. ELMER HOUSLEY
Electrical Engineer, Aluminum Ore Company, East St. Louis, Mo.

PRESENT economic conditions of the country invite a closer scrutiny of the means employed in the administration of an industrial-plant electrical department. A healthy condition is found where a system has been developed to co-ordinate the work of the various branches of the department and to develop the initiative of the individual. A good system will require that only a skeleton outline of most of the jobs be made by the foreman, leaving the workman to devise the most effective methods of accomplishing all tasks within his capabilities. It is well, however, not to be so carried away by system that finally a distorted condition is reached where every action of every person is card-indexed and every move is charted.

Development of brains, not only among the executives but among the men who handle the pliers, is the main object of a successful system. A workman may be preached to, sworn at, laughed at with less benefit than if nothing was said. He will do the things pointed out to him, but a foreman or an engineer cannot be with every workman every minute of the day; hence the necessity to the organization of a method whereby the workman is made to feel that he is to join in "the reciprocal relations and duties" and is not to depend on "asking the boss" for detailed instructions on every job which is outlined to him. When an all-around man is placed on a specialized job with opportunity to work on just the things for which he has

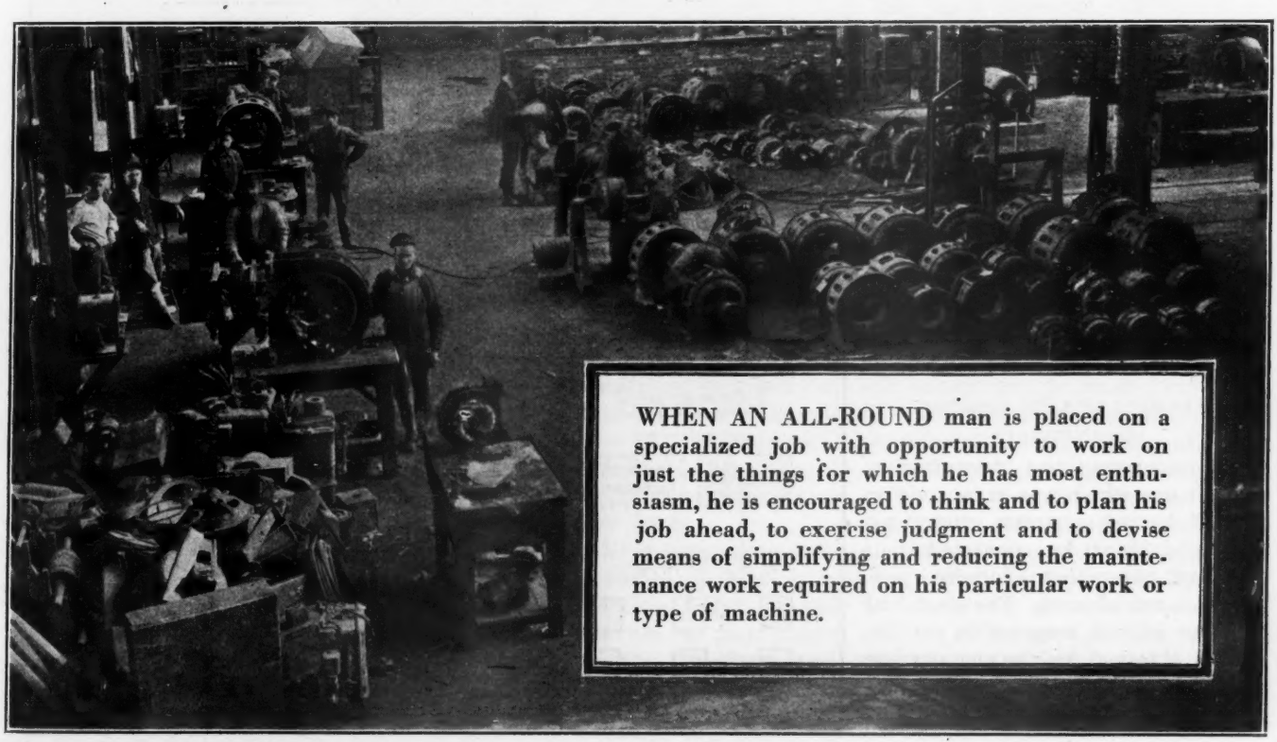
To Develop Leadership It Should be Recognized That:

[1]

THE CHIEF electrician is the intermediary who directs the activities of the men of the department, either personally or through the various sub-foremen, or lead men of various groups, and he has a comprehensive grasp of just what is going on at any particular job of construction or maintenance. He must be something of an engineer in order to follow the design of jobs and execute the details in proportion and in harmony with the general scheme. Alterations made in revamping old equipment require a fine sense of engineering balance in the foremen, as decisions must be made on the spot without calculations.

[2]

THE HANDLING of men and materials represents a problem in organization for reconstruction and new work. In repair work and preventive maintenance this is an equally important problem. A workman may be preached to, sworn at, or laughed at with less benefit than if nothing at all had been said.



WHEN AN ALL-ROUND man is placed on a specialized job with opportunity to work on just the things for which he has most enthusiasm, he is encouraged to think and to plan his job ahead, to exercise judgment and to devise means of simplifying and reducing the maintenance work required on his particular work or type of machine.

most enthusiasm, he is encouraged to think, to plan his job ahead, to exercise judgment and to devise means of simplifying and reducing the maintenance work required in his particular work or type of machine. In such work the engineer in charge should pass upon ideas that are developed, guiding to fruition methods which are based on sound engineering principles and discouraging in a friendly way work along lines not likely to prove of value.

The expansion of the individual-motor-drive idea has contributed to the expansion of the industrial-plant "electrician" into a full-fledged department with many activities. The handling of men and materials presents a problem in organization for reconstruction and new work. In repair work and "preventive" maintenance this is an equally important problem. The storage-battery industrial truck has come to occupy an important and permanent place in industry and requires specialized handling and competent personnel if the full value is to be realized from this efficient labor-saving equipment. More automatic control and starting apparatus is now employed by the mills of the country, and this requires a somewhat different maintenance organization from that required with the regular manual apparatus. With the automatic devices a more frequent and rigid inspection must be made to catch trouble in the incipient stage and thereby prevent a possible production loss. In fact it is from the maintenance crews that the most rapid and effective results of proper organization of the department come. It is largely true that a workman will take twice as long on work assigned after equipment breaks down as if he had the responsibility for the continuous operation of the equipment, his job then becoming a constructive one and not simply one of restoration.

Example of a Successful Organization

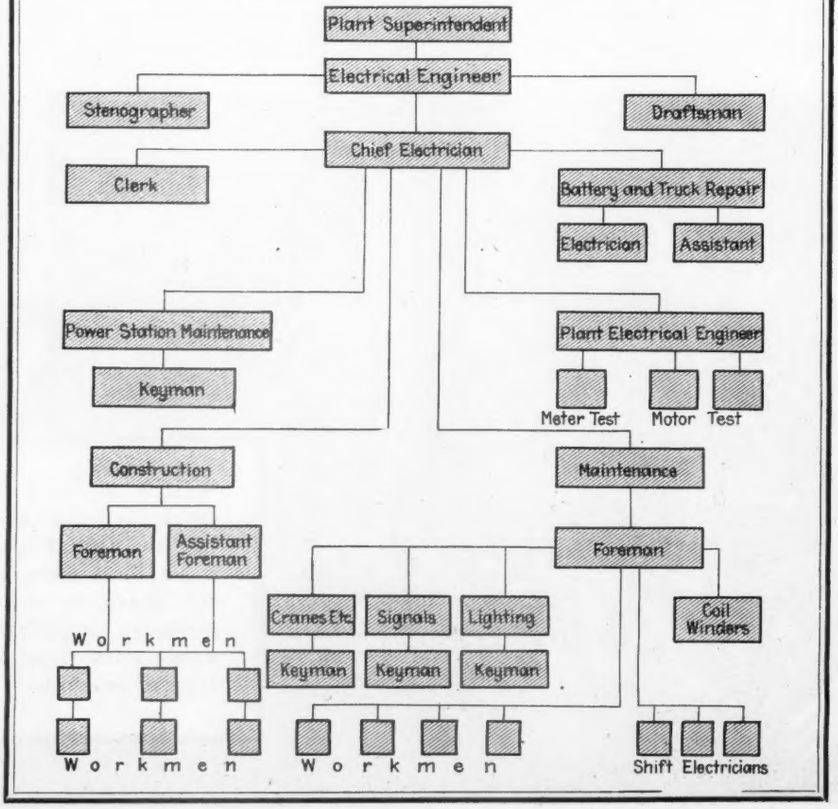
The accompanying organization chart is one which was arranged for a plant having a power generating station of 25,000 hp. connected load, and employing about a hundred people in electrical work. The electrical engineer is held responsible for the results obtained by the department and directs its policies. The engineering of new construction is directed from his office, as well as the investigation of any unusual maintenance work or problems connected with the inadequacy of any apparatus. The specifications of new material and apparatus come from his office, as do all tests as to adaptability or usefulness of equipment. Requisitions for repair and stores-material must pass his scrutiny. A large part of his time is devoted to the review of the results and policies of the department, with a view to betterment and the adaptation of new ideas and methods to the work in hand.

The chief electrician is the intermediary who directs the activities of the men of the department either personally or through the various sub-foremen or "lead men" of various groups, and he should have a comprehensive grasp of just what is going on at any particular job of construction or maintenance. He must be something of an engineer in order to follow the design of jobs and execute the details in proportion and in harmony with the general scheme. Alterations made in revamping old equipment require a fine sense of engineering balance in the foreman, as decisions must often be made on the spot without calculations. The men who report direct to the chief electrician are the construction, shop and meter foremen and "lead men" from various groups, such as crane repairmen, signal repairmen and so on.

The construction foreman and his assistant follow up the new jobs closely and are at hand to settle any questions of interpretation of prints, to furnish orders for the necessary material and to see that the store-room department makes delivery of the material as specified. The men should never be required to leave a job to obtain material. It is the construction foreman's task to have the various jobs lined up so that men will not be idle on account of bad weather or because another job is not scheduled for the men as they finish that on which they have been working.

The shop foreman has general supervision over the tool room, coil-winding room and winding benches. The shift electricians and "key" men work under his direction in the repair of all breakdowns. He has the responsibility for the proper baking of all armatures, stators and coils and maintains all records of the

Electrical organization for plant with 25,000-hp. in motors



General maintenance in this plant is handled by four electricians.

windings put in each rewound motor and any change of voltage, speed or frequency which might be made in a winding. He turns all motors having changes made in the motor characteristics over to the plant electrical engineer, who conducts the necessary tests on the equipment. The shop foreman makes routine tests of rewound motors, such as "megger," insulation and full-load tests. It is his duty to maintain a point of contact with the machine shop and place all shop orders for work which is done by the mechanical department for the electrical account.

The plant electrical engineer is usually a junior engineer rounding out his practical training. In addition to being responsible for all testing work and metering equipment he is charged with the maintenance of all records and statistics of the department. This includes the records of all purchasing-department requisitions for new material, requisitions of material from the storeroom and the triplicate copies of requisitions being used in making up special cost reports, such as those concerning industrial trucks, lamps, and so on. He must co-operate with the engineers in other divisions of the manufacturing program, especially in regard to tests made on "production" electrical equipment, in order that the relation of power, efficiency and adaptability of the drives may meet the highest standards of production.

The industrial electric trucks can be profitably put in charge of a particular electrician when there are as many as ten trucks in service. The organization under discussion is one for seventeen trucks and four trailers. The electrician serves as the "key man" and has an assistant who under his training should be able to step into charge of the work at any time.

Routine Maintenance Is Handled by Four Groups of Men

The general maintenance of a routine nature is handled by four electricians acting as "key men" for the four general subdivisions—direct-current equipment, signals and communication, switchboard and power apparatus, and the plant lighting system.

The direct-current division has the upkeep and regular inspection of all traction equipment, elevators, cranes and hoists. This includes all special direct-current motors and their control apparatus. This routine work eliminates largely the destruction of armatures from low bearings and discovers worn-out commutators, short brushes and brushes becoming stuck in the brush holders. Prompt replacement of worn contactors on control boards and maintenance of good contacts in the control wiring insure against many service interruptions which would otherwise occur.

The signal and communication division is responsible for the maintenance in working order of the automatic telephones for plant intercommunication, the fire-alarm systems, the automatic call system for locating the department heads while out in the plant, the X-ray and other special equipment of a delicate nature.

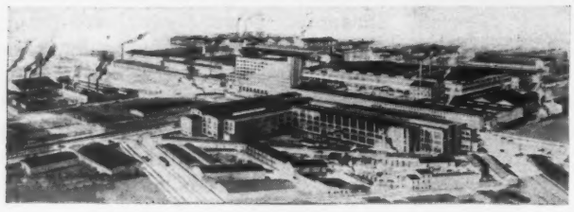
The switchboard and power apparatus division is responsible for the continuous functioning of the exciters, voltage regulators and synchronous power-factor regulators, relays, rheostats, control systems, automatic engine stops and similar apparatus. As the power-generating equipment is the heart of industrial activity, this maintenance branch should be rigorous as to inspection and prevention of possible interruption. It is far better to err in having an excess of time spent in inspecting and testing than to have one relay fail to open a circuit.

The lighting system division is largely dependent on reports of actual outages and of failures of switches. However, it has been found advantageous to employ some very active individual on this work in order to insure rapid and effective clearing of trouble and replacement of circuits, instead of handling this class of work with the regular troublemen.

The coil-winding department is an indispensable adjunct to the large industrial electrical shop, since the varied sizes of motors and the many different styles of coils required almost preclude the great investment expense of carrying a complete stock of coils in the storeroom. A few well-chosen sizes of magnet wire carried in stock and an efficient coil-winding department will often be found to reduce the usual investment in motor coils about 75 per cent and avoid the inevitable loss due to deterioration of varnished coils in the sizes which may be necessary only in the distant future yet must be carried for any emergency which might arise. For this work women have proved the most efficient and satisfactory and should be employed wherever proper working conditions may be arranged. One of the women may be made forewoman of coil-winding operations. In the organization outlined there are four to five women employed in the work of loop winding, breaking or forming, taping and varnishing new coils and retaping and varnishing old coils. Work is assigned to the forewoman by the shop foreman and is in turn distributed to the various workers in the department.

Present conditions with industries running (*Continued on page* 155)

ELECTRICAL REVIEW AND INDUSTRIAL ENGINEER



DANIEL H. BRAYMER
Editorial Director

Assisted by
G. A. VAN BRUNT E. H. HUBERT C H. REEDER

Chicago, February, 1922

What Speed in Making Repairs Means

THE most important object in repair or maintenance work is to decrease the amount of idle machine time. What this idleness actually costs depends upon how vital the idle equipment is in a chain of production processes. In some instances, as in the interruption of crane service, a whole section of a shop may be forced to wait until the repair is completed. Responsibility for the value of the time of the men idle and of their idle equipment rests upon the shoulders of the men making repairs — the men who are depended upon to get the machinery going again.

One hundred men idle at sixty cents an hour means a dollar a minute for wages alone. The value of the time of the machines and the space they occupy will frequently be greater than that of the men who operate them, for it is not uncommon for machines to earn on a production basis from four to five dollars an hour. The actual labor and material cost of making a repair may be a mere trifle compared with the expense of the idleness but the importance of the repair job itself is comparable to the sum total of the values that have been mentioned.

Profit by Your Failures

THE consoling expressions, "don't cry over spilt milk" and "nobody likes a quitter" can often be applied in maintenance and repair work. Be as cautious as you can and something will let go at the unexpected time once in a while. To look upon such failures as an opportunity for an investigation that will pin some bit of carelessness on an operator or repair man is not only the wrong spirit, but an attitude that eliminates from the investigation one of the essential elements; namely, the knowledge of the men who know most about the case and their full and frank suggestions on preventive measures for the future.

Men who never make mistakes seldom do anything worth while and shun responsibility. In the case of an accident, preventable or otherwise, it's the time to accumulate courage and show speed in repair, not in the use of favorite cuss words. Then after everything is running again, sit down and carefully analyze in report form every failure of man and machine, with malice toward neither. After this, don't make the mistake of filing the report with the office management; give a copy to the men and talk it over with them. If they are made of the right stuff they will profit most by it. If they are not an examination of the report in a day or two for thumb marks and side notations will make that point plain.

How Big Is Your Material Handling Problem?

FEW industrial engineers appreciate fully the importance and extent of their material-handling problems. Altogether too frequently they measure it by the daily output; ten tons a day output with them means ten tons a day to handle. What they really mean is that ten tons are handled out of the shipping room and only one handling of perhaps scores is considered. Each time the material, the equipment, or the containers, are picked up is a handling; it adds to the tonnage and increases the cost.

In some lines of work the handling problem is greater than in others; for example, in the foundry almost every operation involves the handling of materials which include sand, loam, pig iron, scrap, coke, molds, parts cast, debris and the like. There are a few exceptions such as weighing, but—the bringing of the material to the scales and taking it away means a handling. The stop for performing a weighing operation is momentary compared with the length of time consumed in the handling to and from the scales. In contrast, for lathe and planer work much more time is given over to the operation than is given to the handling—it may take only a few minutes to put a big casting or forging on a lathe or planer but it requires several hours to do the machining.

Ordinarily in manufacturing each operation requires at least three handling operations: (a) the piece must be lifted onto the machine; (b) it must be lifted off the machine; (c) and it must be carried to the next machine. Even though the actual transfer is automatic, or is done by hand, it nevertheless is a handling. Thus, machining a ton of castings at six different machines would mean approximately eighteen tons handled. Because of the wide variance in the amount of work required in machining different parts it is difficult to estimate the total amount of handling necessary to get a ton of machine shop products. One engineer has found that altogether 168 tons of material are handled to get one ton of finished castings. This was computed on the basis of a 3-lb. casting and was checked against plant practices. In these computations only movements of material which were absolutely necessary in practice were included. Additional handlings such as repiling or unnecessary reloadings would increase the tonnage and consequently the cost.

These 168 tons *must* be handled. The problem before the industrial engineer, then, is to choose the best method of doing the handling. For example, a magnet will pick up the pig and scrap much more cheaply

than it can be done by hand; electric cranes or storage battery trucks will carry the sand, scrap, pig, loam or castings at less expense than can men with wheelbarrows, and sometimes conveyors or trolleys may be used at additional savings. Which is best always depends upon the circumstances. The "Handling Materials" department, which in this issue begins on page 147, shows several methods actually used to reduce handling costs. Some of these may apply to operations in your plant.

Training the Mind to Observe and Compare

IN order to be a good trouble shooter, the repair man must be what the physician terms a good diagnostician. This refers to the ability to observe symptoms closely and accurately, and by comparing them with the facts which have been gained by previous experience, to determine the cause of the symptoms. These same qualities of mind are very useful, if not essential, in all inspection work.

Most of us really see only a small part of what is going on 'round about us and we generally see that small part very casually. By a little effort and training it is possible, however, to cultivate the habit of observing closely and remembering those facts which will be of most value in daily work. Of course, one is more or less unconsciously gaining information all the time, but a conscious effort in this direction will usually bring out many things which would otherwise pass unnoticed. Such a program persistently followed out will in time result in the accumulation of a storehouse of facts and information, if properly supplemented by the reading of technical books and magazines dealing with the work in hand. New problems are constantly arising which require for their solution the products of this storehouse and he who has this sort of mental material will seldom find his services without demand.

What the Foot-Candle-Meter Tells You

NO more useful and profitable instrument than the foot-candle-meter, has been provided works maintenance men in a long time. It has done more to drive away the mystery of funny looking curved diagrams and the trigonometry used to indicate light intensities than any single thing. For with this instrument he can go from department to department and from machine to machine and get information that means something to him. The only thing left now to his good judgment is the reflection of light from the work to the eye. The foot-candle-meter gives him the foot-candles of illumination delivered to the work. But when he once gets a good example of lighting for his conditions, comparisons can be determined with useful precision. The main thing is to become familiar with this instrument, learn to use it and then study the improvements in the kind of work done and increases in the amount of work done.

The one thing that will become apparent at once is the relatively low lighting efficiencies that will be found, probably in the range of 2 to 4 foot-candles. This is the signal for investigation for it has been pretty definitely proven that intensities as high as 15 or 20 may be needed on some kinds of work. A good deal of useful experimenting can be done by consulting with manufacturers of lighting fixtures, installing different types of reflectors and measuring the intensity of illumination. Other practical information can be secured by taking photographs with the same exposure and same camera setting for different reflectors and sizes of lamps. Such photographs will show up shadows and help to eliminate guess work in comparing illumination effects.

In one plant making automobile gears and transmissions the best intensity on the work was found to be 15.35 foot-candles, and this was obtained on an energy consumption of 1.6 watts per square foot which indicates that good lighting is not as expensive sometimes as ignorance of it. The foot-candle-meter will help to show how surprisingly low the cost of increased illumination is when measured against the results in better work that you can get.

Economy— What Is It?

ECONOMY and efficiency are words that are much abused. In defining the former Webster gives seven viewpoints with sixteen variations in which the terms management, rules, regulations, principles, thrift and traits of character are employed. But Ruskin, in his lecture "A Joy Forever," comes close to the point in the following statement which tells what economy isn't. "Economy," he says, "no more means saving money than it means spending money. It means spending or saving whether of money or time or anything else to the best possible advantage." Whatever economy may be, it certainly involves experience, observation, perception and common sense, and it does not abide among the careless, the slothful and the bigoted. Among this group observation sometimes produces the desire to demonstrate economy, and many an ordinary individual with just good common sense and the opportunity, has made a place for himself by the benefits measured in dollars that have resulted from the application of normal intelligence commonly known as "horse sense."

In the field of industrial operations a great laboratory for free use of this gift of nature is now open, where spending a little time and not much money will show real results. To be specific, the work in this great laboratory includes analysis of troubles that frequently occur at the same point or in the same machine; the complaints of workmen that their tools are not adequate; the needs to revise equipment to handle different classes of work; the many spoilages that are found at machines and the clogged alleys where slow speeds of man and machine seem to be at fault; the lack of light to enable man's eye to keep up with his hands, and hundreds of other studies. While the electrical man in charge of works maintenance has not, perhaps, been definitely assigned to these jobs, his accumulated knowledge of failures and the applications of electric service, is just the tool that may fit the job and he should not be afraid to try it out.

And They Came

Without Sounding Trumpets or Beating Drums

IN last issue I said that I was not surprised a bit at the cordial response from readers who received the first issue. I'm afraid I spoke too quickly, for I, too, must blush now with the editors at the stack of subscriptions being piled up—an increase of almost 4,000 paid orders in less than 60 days. I have just woke up to the fact that as "Sponsor for the Average Reader" I have a real job with a real crowd of men who are doing things and know a good thing when they see it.

When I found on March 1 that I could not get five copies of the February issue to send to some friends because these new subscribers had beat me to it, I made a little side investigation of my own to see who these fellows might be to whose interests I must attend. And I'm here to tell you that my friends and your friends are there from plants whose names are attached to nationally known products. So I have asked that those plants be analyzed for classes of industries, products made, uses of electric service, and a few other things. I may have something to say about this later on for it will help us to get together into groups with mutual interests.

I've reserved ten copies of the March issue already. If you want yours, you had better move fast.

Practical Pete

P. S.—Here are a few more letters just as good as those I abstracted last month. Because the subscriptions of many readers must start with this issue and they did not see the announcement of subjects for articles to come, in the February issue, it is repeated here. Look it over and send in any suggestions you may have.

"I received the February issue and was so well pleased with it that I hate to miss any of the copies. If possible, I would like to have my subscription begin with the January issue. I am sending the names of two friends who would like to subscribe."
Appleton, Wis. Clyde Cavert.

* * *

"The very first copy contained a lot of information that was useful to our repairmen, so I am having another copy come through the company for the men as well as my private one. The industrial engineer idea strikes me very forcibly, as I am one of the many who are combining practical experience with technical education."
Kenogami, Quebec. N. D. Paine.

"The foreman electrician working for me has asked if he could become a charter subscriber on the same terms as I did. He has read the first copy and likes it very much."
Belleville, Ont., Canada. J. H. Gallant.

* * *

"Enclosed is check for my subscription and one for Mr. Elm Persson. This is a publication that he and I have long looked for. We feel that with D. H. Braymer as editorial director we are going to get some paper."
Albany, N. Y. J. Hannaway.

* * *

"Having been a stockkeeper in industrial plants for the past eight years, I am naturally interested very much in Mr. Barbera's article in the January issue. I consider that article very complete. It deals with the fundamental principles which underlie the successful conduct not only of the electrical stockroom but of the general stockroom as well. Too much importance cannot be placed upon the perpetual inventory."
Fillmore, Calif. F. E. Millard.

* * *

"I am very glad to learn that you are developing a journal for the operating man. I am interested in what the other fellow does and like more detail than is generally given. Large companies have the conveniences to make tests, etc., and issue specifications and instructions for different lines of work which

have been found efficient and practical. For instance, I would like to see published specifications for meter installations, line work and general construction work. I would like to know also what sort of motor inspection is followed; how often the motors are painted, and the kind of repair and inspection records that it has been found advisable to keep."

Woodland, Me. H. L. Hayes.

* * *

"I am interested in your new undertaking, Electrical Review and Industrial Engineer, because there exists a field (or gap) not closely covered by any publication, in so far as I know, dealing with electrical and mechanical equipment in industrial plants, their relation to costs and production. Because this interests me and because of the many favors you have granted me I will be glad to contribute and to assist in any way I can. I think that the greatest and immediate results can be obtained by an appeal, primarily, to men in the position and grade of works electricians and master mechanics, and secondarily, to operating executives."

New York City. Charles E. Mead.

* * *

"I am heartily in accord with your new venture and believe you will fulfill a long-felt want in covering the industrial field. It has appeared to me that the industrial application of power has largely been presented from the standpoint of the power company engineer and not so much from that of the industrial plant. In many cases these viewpoints are radically different.

"Your stand in confining the highly theoretical dissertations to the Electrical World is good. There are many cases where the omission of the application of theory in the use of power would detract from the value of the magazine. There is a distinct value to the development and executive side of industrial electrical work which is too frequently overlooked, especially in the smaller plants. This would appear to me to be worth considerable development."

El Paso, Texas. T. H. Arnold.

* * *

"I hasten to congratulate you on the forward step taken by the McGraw-Hill Company in acquiring the Electrical Review. There has always been evident to me a serious lack in the electrical field of a publication serving the same purpose as does the American Machinist in the mechanical world. None of our national publications so far have found themselves in the field of the practicing electrical man in the mine, mill and factory. My own experience in connecting up theory with practice, and the ideas on this subject of the practical man in the shop, have convinced me that the dissemination of practical assistance to the electrical worker in our industrial establishments is a most important mission of the technical press.

"Another feature which might well be made of importance is that of attention to the young man ambitious to advance through his own efforts. There are many such men in our shops and factories today.

Honesdale, Pa. J. M. Walsh.

* * *

"I was pleased to receive the announcement relating to the new journal. The word 'practical' appeals to me. Most of the mechanical papers today are given over to a great deal of technical material, which I venture to state, a large number of the readers are not interested in. In my experience of 32 years as operating and chief engineer, I have observed that the every-day mechanic will pick up his paper, look at the pictures of new plants, and then turn at once to the sketches, letters from the plant, etc., study them and comment on them. Charts of temperature curves mean nothing to him, and algebraic equations are so much Greek."

Camden, Maine. M. M. Brown.

Articles to Come Will Deal With These Topics

[1]

Organization of inspection and maintenance departments.

[2]

Practical information and procedure essential in the inspection and maintenance of industrial electrical equipment.

[3]

Scheduling and handling of work in repair shops.

[4]

Procedure in overhauling and remodeling existing systems, both mechanical and electrical.

[5]

Problems in layout and installation changes of lighting and power wiring.

[6]

Details of methods and schemes for handling installation changes in electrical and mechanical systems.

[7]

Practical schemes used in making changes in electrical and its associated mechanical equipment to improve operation, to reduce operating and maintenance costs, to protect men and machines and to formulate standards of practice under different conditions.

[8]

Tests to determine the power requirements of machines in different industrial operations.

[9]

Studies of operating costs and of the apportionment of the cost of electrical energy used in different industrial operations.

[10]

Details of methods of using instruments and tools essential to the making of tests and repairs.

[11]

Analysis of stock keeping methods that are essential to the adequate maintenance of plant equipment.

[12]

Operation and maintenance of special processes that depend upon the successful application of electrical energy, such as heat treating, electric welding, electric furnace applications, electroplating, etc.

[13]

Studies in industrial lighting from the standpoints of maintenance of existing systems and changes to meet the illumination requirements of department processes.

[14]

Analysis of improved operating practices in the handling of materials from their raw state to the finished product.

[15]

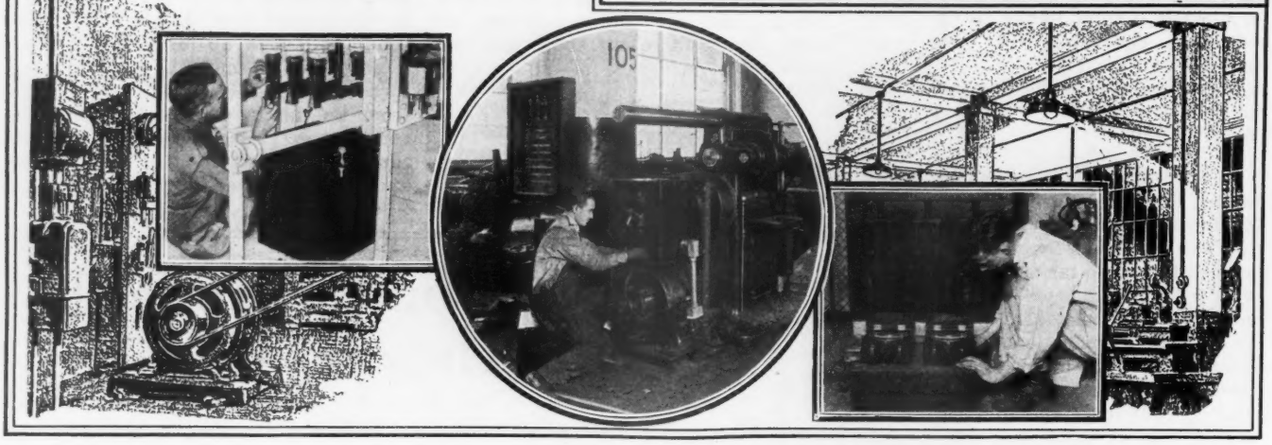
Analysis of service requirements, testing and maintenance of factory signal systems, such as telephone, fire alarm, watchman and time clock and special call systems.

IN the editorial treatment of articles, practical methods in handling installation work, in repairing equipment and in maintaining continuity of service in existing works, will predominate over the engineering considerations involved in the design and layout of equipment in new buildings. The viewpoint of the supervising operator rather than the electrical engineer will receive first consideration and the paper will talk his language rather than the technical language of the electrical and mechanical engineer.

WHEN the installation of electrical systems in mill and factory buildings is discussed it will be from the standpoint of both electrical and mechanical engineering practice, considering the viewpoint of the supervising head responsible for the inspection and maintenance of the systems involved.

SERVICE
around the works

For this section ideas and practical methods devised to meet particular operating conditions are invited from readers. The items may refer to inspection, overhauling, testing or special installations.

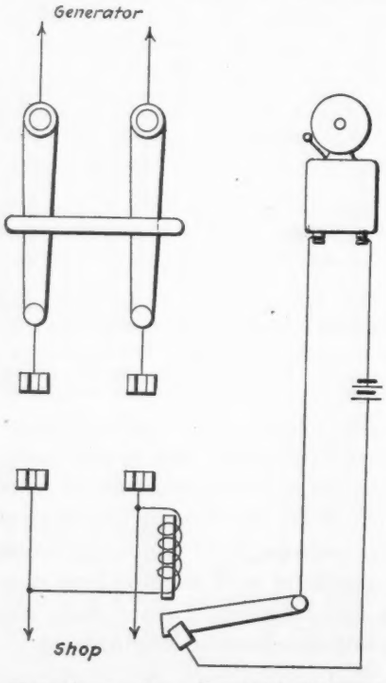


Alarm That Indicates When Circuit Breaker Opens

ON PAGE 37 of the January issue of ELECTRICAL REVIEW AND INDUSTRIAL ENGINEER, J. M. Walsh of Honesdale, Pa., showed a circuit breaker alarm bell which rings when the circuit breaker opens. A modification of such a circuit arrangement which has been successfully used by the writer is shown in the accompanying illustration. In this sketch a connection is made from the shop side of the main switch to the relay which holds the contactor while the breaker and main switch are closed. If either is open or the control circuit damaged, gravity will cause the contactor to drop into knife-switch jaws, and close the alarm circuit. When it is intended for the shop circuit to remain dead, a wooden plug can be inserted in the switch jaws to prevent the contactor from closing the alarm circuit. The advantages of this arrangement are:

1. Action of the alarm circuit is positive; that is, should any portion of control circuit become inoperative an alarm would be sounded.
2. One coil is used instead of two, and there need only be sufficient ampere-turns to hold the contactor against the relay poles. The contactor is placed in that position by hand, reducing current consumption.
3. Should the main switch be opened without the attendant's notice an alarm will be sounded.

Trenton, N. J. W. A. OEHLSCHLAGER.



Bell rings when circuit breaker or main switch is opened.

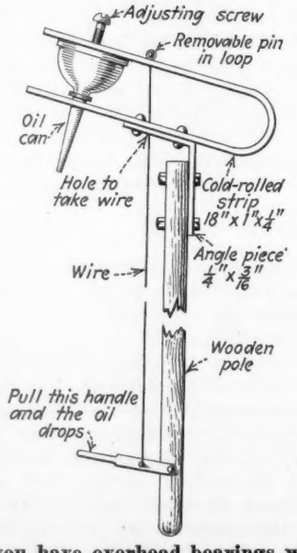
Pilot Lamp in Motor Circuit Near Starter Tells Whether Motor is Running

IN THE plant where the writer is employed a 440-volt, 60-cycle, 2-phase, 4-wire motor is located in a pump house on a stream about a mile from the power plant where the starting switch is placed. Formerly there was no way of telling whether or not this motor was running until the shortage of water became apparent or someone happened to notice that the starter had kicked out. As a means of indicating when the motor is running, two 250-volt lamps were placed in series across one phase and mounted near the chief engineer's desk so that he would notice if they were not lighted. This scheme has worked so satisfactorily that several other motors have been equipped in the same manner.

Batavia, N. Y. N. S. DAVIS.

Oiling Overhead Bearings with Oil Can Fastened on Long Handle

AN OILER for use in places overhead, on line-shaft bearings and the like, will be found very useful in the shop and can be easily constructed as shown in the drawing. It consists of an oil can mounted point



If you have overhead bearings why not make a device like this?

down on a wooden rod. By pulling on the trigger handle the oil is forced out.

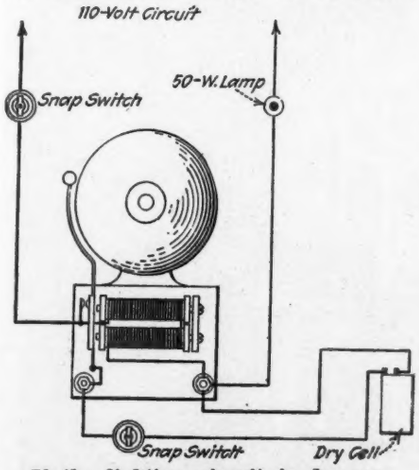
In making the oiler a bent piece of 3/16-in. iron is fastened to the end of a wooden pole as shown. A strip of cold-rolled steel about 18-in. long, ⅛-in. thick and 1-in. wide is drilled at one end to take the snout of an oil can at the largest part of its taper. The other end of the strip is drilled and tapped for a 14-20 screw. The strip is then bent into a "U" and mounted as shown on the iron piece. A wire running through the lower half of the strip angle piece connects with a handle which is pulled down when it is desired to compress the oil-can and force out oil. A pin put through a loop in the upper end of the wire allows it to be disconnected for removing and filling the can.

DEXTER W. ALLIS.
Whitman, Mass.

Ordinary Bell Indicates Condition of Circuit

WHEN used as an alarm to indicate that a source of energy supply has failed, the scheme illustrated has proved very dependable, simple and inexpensive. An ordinary iron-box bell is used, the coils being connected permanently in series with a 50-watt, 110-volt lamp to a 110-volt circuit.

Under ordinary operating conditions the current through the lamp is sufficient to keep the armature



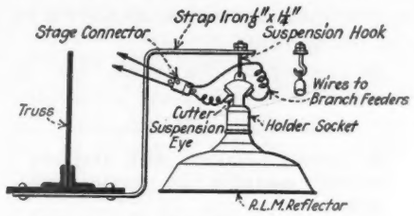
If the lighting circuit is de-energized the bell will ring.

pulled against the pole pieces. When the armature is in this position no current flows from the cell, as the contacts are held open. If the main circuit is de-energized the bell armature springs back against the contact breaker, thus closing the cell circuit and causing the bell to ring in the usual way. The hum produced on alternating-current circuits can be eliminated by mounting the bell on rubber or cork.

C. C. MOLER,
Superintendent,
Northern Virginia Power Co.,
Winchester, Va.

Lighting Reflector Mounted Out of the Way of Traveling Crane

IN ORDER to avoid a traveling crane, the lighting unit shown in the accompanying drawing was mounted on a piece of strap iron so that the bottom of the reflector came just level with the ceiling truss and was out of the way of the crane.



Mounting for light unit where there is insufficient clearance under the trusses.

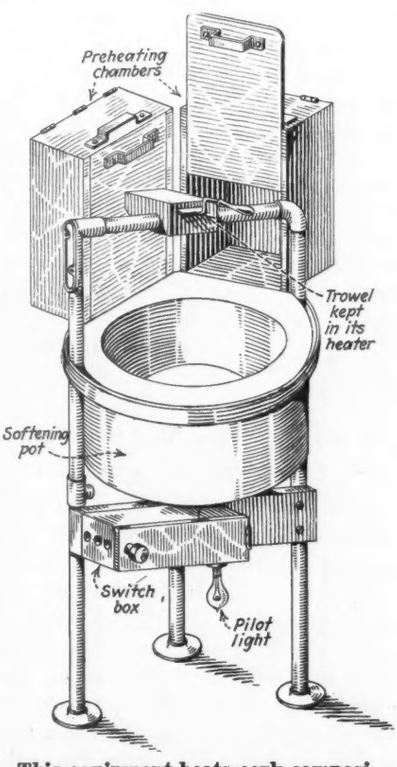
For a support a piece of ⅛-in. x 1¼ in. strap iron, bent in two right-angles, was fastened to the lower edge of the steel beam. The unit was hung on a suspension hook passing through the outer end of the strap-iron support by means of a Cutter suspension eye, No. 196. An R L M reflector is employed to throw the light downward. The connection was made to the branch feeder through a stage connector. This allows the entire unit to be disconnected and removed to a safer place for cleaning. When the unit is disconnected it is replaced immediately with a clean unit so that it is not necessary to bring back the original after it is cleaned.

SAMUEL G. HIBBEN.
Consulting Illuminating Engineer,
Westinghouse Lamp Company.
Bloomfield, N. J.

Electric Heater Softens Cork Composition and Maintains Uniform Temperature

THE electric heater shown in the accompanying illustration was designed to soften the cork compositions required in the manufacture of certain types of shoes. The composition is used to fill in the space caused by welts or seams between the inner and outer soles. The heater consists of two preheating pots and one softening pot and will hold 12 lbs. of the cork composition. It requires a total energy input of 2.5 amps. at 110 volts to heat the composition to the proper working temperature of 230 deg. F. with a use of 4 lbs. of composition per hour.

One heating element of the softening pot consists of 131 ft. of No. 15 B & S gage nickel-chrome resistance wire wound in one layer around the outside of the inner pot. About 69 ft. of No. 15 B & S gage nickel-chrome resistance wire is wound in one layer on a piece of ¼-in. sheet asbestos cut into the shape of a square cross, which is placed at the bottom between the inner and outer melting pot. The resistance wire on the side of the pot is insulated from it with sheet asbestos 1/16 in. thick. The softening pot is made of No. 22 gage galvanized sheet iron and the inside dimensions are, bottom diameter 9.75 in., top diameter 12 in., vertical depth 5 in. The wire on the bottom heating element is connected in series with he resistance wire on the side of the pot.



This equipment heats cork composition for shoe soles.

Preheating chambers supply the required preliminary heat for the composition and a special compartment keeps the trowel at working temperature when not in use. The pilot light shown below the switch box indicates when the energy is turned on. Separate heating coils are provided for the pot and the preheaters, the coils for the main pot being connected for regulating purposes through a thermostatic control device.

The minimum dimensions of the preheating compartments are 12 x 6 x 9 in. and their bottoms are on a level with the top of the softening pot. The preheating compartments are made of No. 22 gage galvanized sheet iron insulated on the outside with asbestos. The bottom side is inclined towards the softening pot, the top is hinged for the reception of the composition, and there is a sliding metal front which can be adjusted to any height to permit the composition to run out. A heating element similar to that used under the softening pot is also installed under each of the preheating compartments.

The temperature of the composition in the softening pot is kept constant by the operation of a thermostat through which the current is switched on and off. There is no thermostat control on the preheating compartment. The soft cork composition is spread on the soles of shoes with a trowel and the trowel receptacle just above the softening pot is kept warm with a standard 150-watt 110-volt cartridge type heater.

There is a lamp outside of the switchbox which shows whether or not service is being supplied to the heater. The electric heater has effected a saving both in operating cost and in composition compared with the steam heater which was used previously. The steam frequently burned the composition, but that never happens with the automatic electric heater.

ALBERT KOCHS.
Chief Engineer,
Hamilton-Brown Shoe Co.,
St. Louis, Mo.

A Way to Keep Rubber Tape From Sticking to Connectors

Any man who has tried to take rubber tape off motor or screw connectors knows some of the troubles. For that reason, the method we use to make such joints easier to open will be appreciated. The secret is to wind along with the rubber, the cloth strip which comes between the turns of a roll of tape. Instead of stripping this cloth from the rubber, use it. It is placed against the connector with the rubber outside, then cloth and rubber are applied like a single strip of tape. After the rubber is in place, friction tape is applied as usual.

The cloth will prevent the rubber from sticking to the screws and the connectors. Of course, the insulating value of the cloth is not great, but as it is very thin the finished joint will be practically the same size as one in which the cloth is not included.

N. S. DAVIS.
Batavia, N. Y.

Mounting Oil Circuit Breakers on Angle Iron Frame Facilitates Inspection and Repair Work

IN AN Eastern industrial plant eight Westinghouse Electric & Manufacturing Company Type 816 oil circuit breakers equipped with inverse-time-element overload release are mounted on a 2 in. by 2 in. by 3/16 in. angle iron frame and are spaced so as to give ample room for inspection and repairs, as shown by the photograph.

At the top of the frame there is mounted a steel bus-box containing the three ¼ in. by 3 in. copper bus bars mounted on alberene stone supports. At the bottom of the frame is placed a steel box containing a 3-pole, 600-ampere knife switch for disconnecting the bus from the line when making repairs. Three 750,000 circ. mil rubber-covered double-braid cables are run in 3½ in. conduit from the switchboard to the bus box through the 3-pole switch box to supply the 3-phase 440-volt current. The connections from busbars to oil circuit breakers are made with three No. 1 rubber-covered tape-and-braid cables run in 1½-in. conduit, the cables being bolted to the busbar by a ⅜-in. bolt through a flat solder terminal. All of the branch circuits from each breaker are No. 1 rubber-covered tape-and-braid cables run in 1½-in. conduit. Each breaker controls branch circuits to induction motors with a maximum of 80 hp. on any one circuit. These motors vary from 1 to 50 hp.

F. W. MCGRAW.
Swissvale, Pa.

Oil circuit breakers with overload release mounted on angle iron frame.

Connecting Auto-Transformers in Parallel with One Secondary Switch

BY CONNECTING auto-transformers in parallel as shown in the accompanying sketch only one secondary switch is necessary.

Ordinarily on a lighting panel like that shown two transformers are provided, each one capable of carrying the total load independently. Only one is used at a time, the other being available in case of failure of the first one. By connecting as shown in Fig. 1, it will be noted that the transformers can be operated in parallel or independently if desired. When operated independently the second transformer is completely disconnected from the line. The board on which this method was used by the writer recently should have been built with a secondary switch for each transformer, but through an error it was shipped with only one secondary switch. This mistake necessitated a change in arrangement. By a slight alteration in connections the scheme outlined was evolved. It has proven a cheaper and better way than was originally planned.

Fig. 2 shows the front view of part of the switchboard, the panel at the right being the lighting panel. The secondary switch is at the top.

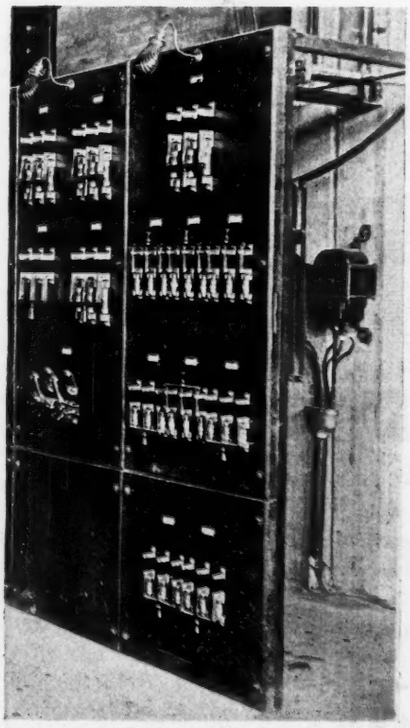


Fig. 2—Panel at right holds the switches for two auto-transformers and six lighting circuits.

Next are the six distribution switches and at the bottom are the two primary switches. One of the two auto-transformers can be seen mounted on the wall behind the switchboard. They are mounted on

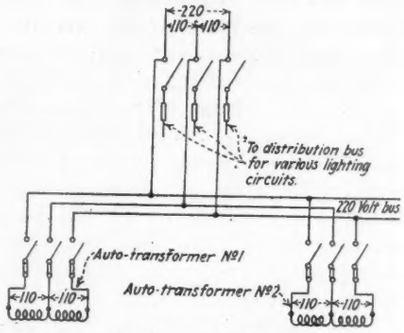


Fig. 1—Diagram which shows how one secondary switch may be used for two auto-transformers.

strap-iron brackets fastened to the wall by means of inserts set in the concrete.

EUSTACE C. SOARES.
Electrical Engineer,
Orphuls, Hills & McCreery,
New York, N. Y.

Some Safety Precautions When Opening High Tension Switches

FOR use in the transformer house of an industrial plant, a pair of long rubber gloves and a dry switch stick with a hook on its upper end, should be available (but in a locked cabinet) to operators only. The gloves should be of the standard quality for linemen, with extra thick fingers. They should never be used for handling rough material, as they may be punctured. Even small holes may allow an employee to get a bad shock when handling high tension apparatus carelessly. The switch stick should be of well seasoned straight - grained hardwood, well shellacked and kept always in a dry place. In front of the high tension switch there should be a thick rubber mat in dry condition.

When operating the switch, have on both gloves to avoid making a ground connection with one bare hand, and keep both feet on the rubber mat. Place the hook securely in the hole at the end of the switch and give a quick pull. Then remove the stick. Never allow it to hang there. In closing switches, keep the hook firmly in the blade hole and close the blade to within two or three inches of the clips, then force it in quickly and firmly.

Never try using "any old" stick with a nail or bolt through its end, and above all, do not take a chance on voltages above 6,600 without using gloves, as high voltages will jump to the ground through very slight moisture on a stick and throw you down pretty quickly. Just remember that nice bouquets cost money, so be careful!

New Britain, Conn. H. S. RICH.

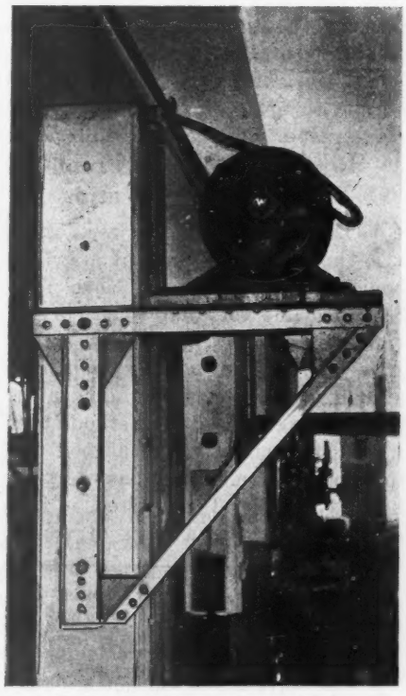
Structural Steel Bracket for Mounting Motors on Columns

A STRUCTURAL steel motor bracket has proved very satisfactory in the new machine shop of the Alamo Iron Works, San Antonio, Texas.

The bracket consists of a 6-in. vertical channel with a 3½ in. by 2½ in. by ¼ in. horizontal angle and a 2½ in. by 2½ in. by ¼ in. brace angle, the three members being riveted to ¼-in. gusset plates with ¾-in. rivets. Two-inch planking is then bolted to the horizontal angles and the motor slide rails bolted to the planking. The brackets are made right and left and are bolted on opposite sides of a column.

The columns, which are of reinforced concrete, had 1-in. pipes set through them on 12-in. centers so that the brackets could be fastened to them with ⅞-in. bolts.

C. A. DONALDSON.
Assistant to Superintendent,
Alamo Iron Works,
San Antonio, Texas.



Steel motor bracket mounted on concrete column.

Intelligent Care Keeps Fine Grinder in Perfect Condition After Years of Service

THE ability of a fine grinding machine to stand up under hard and exacting service, when it is given the proper care and attention,

This surface grinder has averaged 30 finished pieces per hour for the past ten years

is clearly brought out by the record of the Heald surface grinder shown in the illustration.

This machine has been in daily use for over 10 years in a large automobile plant. It is employed to grind off about .003 in. from the face of a hardened steel plate and its production averages about 30 finished pieces an hour. The care which this machine receives is simple but intelligent and effective, as its record of service shows.

How a Switchboard Frame Was Kept from Heating

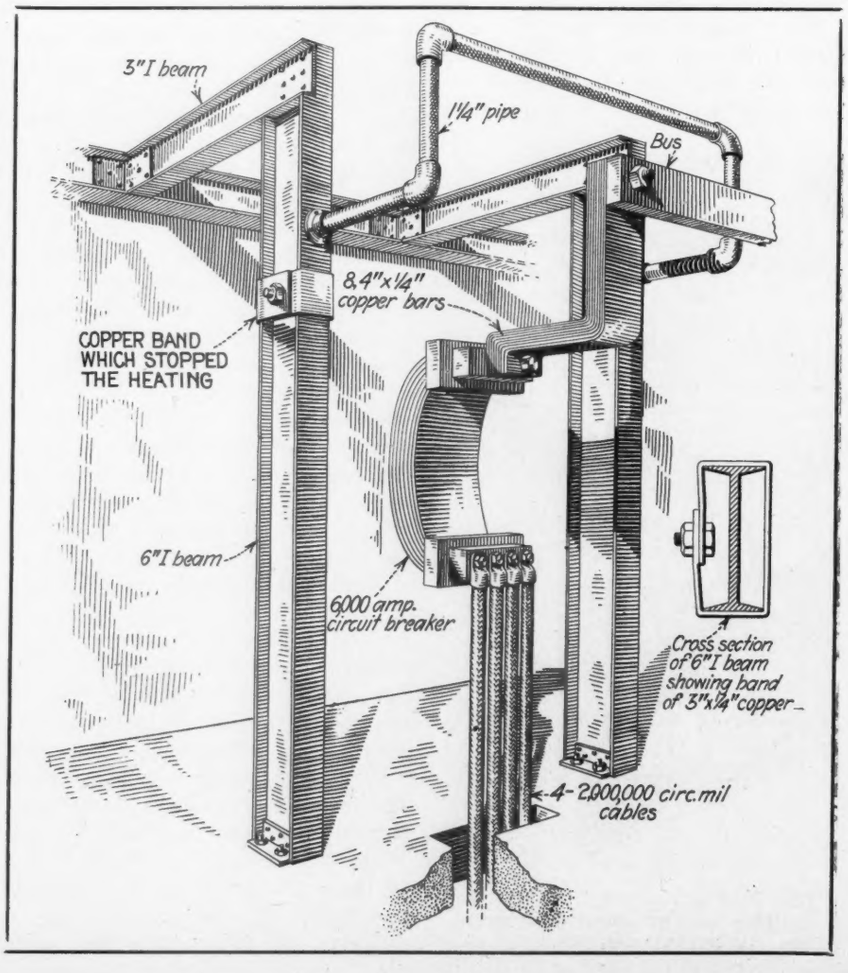
SOME time ago the writer noticed that the iron frame of a switchboard in a factory of New York State became very hot when current was flowing in the supply cables. After much study and experiment a simple way to prevent this heating was discovered. The method used will, I believe, be worth a good deal to some other man who has the same kind of trouble. It consisted, in fact, only in clamping a ring of copper around one of the iron members at its hottest point. Simple, isn't it?

In the substation where this trouble developed the switchboard was made up of six panels like the one shown in the accompanying drawing. This drawing shows only the iron frame and the main copper circuits. The frame was made of upright 6-in. I-beams supported at the top by horizontal 3-in. I-beams. The other end of the horizontal beams was bolted to another horizontal I-beam on the wall. Extending in front of the board was a frame of 1¼-in. pipe as illustrated. On the back of each panel was a single-pole remote-control air-break circuit breaker rated at 6,000 amp. Current came to these breakers from two banks of three 1,000 kva. single-phase transformers on the floor beneath. Current passed up heavy cables in front of the board through the breaker to the back of the board. It left the upper terminal of the breaker at the front of the board and passed into the buses above.

It was discovered that when the heavy current was flowing through the breaker the vertical I-beams of the frame became hot. Moreover, the copper bars and cables at the breaker heated considerably. It was easy to decide that induced magnetism in the iron frame was the cause of the heating. How to stop it was not so easy. At first we planned to break the joints between the different iron pieces and insulate them with fiber or brass. This would probably have cured the disease, but would have been very expensive, as the pieces were large and the joints were many.

Finally, after many experiments we found that a copper band bolted around the I-beams, as shown, completely cut out the heating. At first we put on a band of ⅛-in. x 4-in. copper, but this band itself was heated almost to a cherry red by induced current. Then a band of ¼-in. x 4-in. copper was bolted on, and this time both the band and the frame remained cool. When we found that this would "turn the trick," we put bands on each upright. The whole job cost very little and was done without any service interruption.

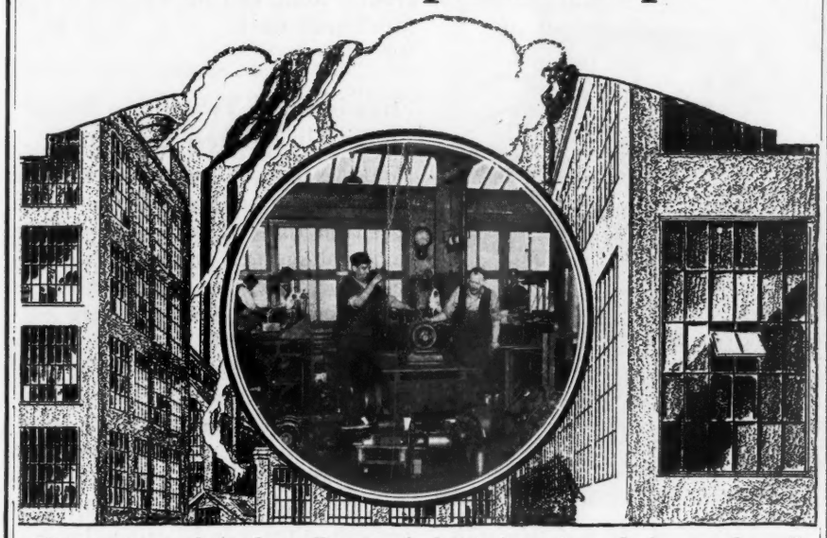
Brooklyn, N. Y. W. E. SEWARD.



Copper band around I-beam as shown stopped the heating.

The two upright I-beams in this illustration form the frame for a slate panel on which the 6,000 amp. circuit breaker is mounted. The panel is not shown in order to indicate clearly the position of the metal parts.

In the Repair Shop



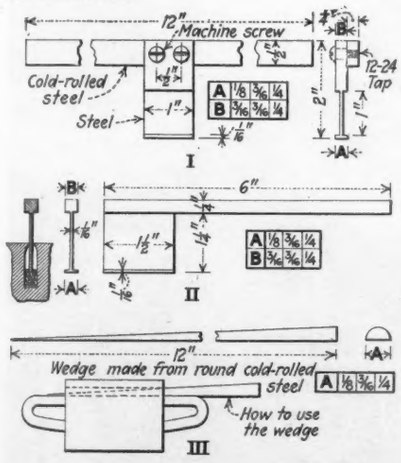
This section is devoted to all sorts of electrical repair work, large and small. Special attention is given to tools found convenient at the shop bench and short cuts or improved methods. Articles on these subjects are always welcome.

Special Tools to Pack Wires In Partly Closed Slots

SOME handy drifts used in winding motors that have partly closed slots and threaded-in types of windings are described below. The tool shown at I was made to enable the winder to force down the wires in the slots on some small stators which had a bore of 4 in. and a core length of 6 in. It is obvious when considering these dimensions that there was no room in which to use a mallet. Therefore a small drift was fastened to a long piece of cold-rolled steel as shown. The length of steel was drilled and tapped and clearance holes were drilled in the "T" drift for the machine screws. In using this tool the winder inserts the drift into the slot and presses down on each end of the bar.

The tool shown at II is a modification of that at I. The handle in this case is made integral with the drift. This tool is very handy, as the winder can hold it and pound along without fear of hitting his fingers. The widths given for *A* as the base of the tool will meet most cases. If a wider slot is encountered then a piece of 1/16-in. or 1/8-in. fiber can be cut to fit the slot and used under the "T" slot drift, or the drift can be held crosswise in the slot.

The drawing at III shows a steel wedge which is a great time saver when winding small single-phase stators. This tool is made from round cold-rolled steel of the proper sizes. The three sizes given in the drawing will cover the majority of slot sizes. One side of the tool is ground flat. Grind as shown by the dotted line, making a wedge starting with a thickness of 1/32 in. up to the full diameter of stock used. After grinding round off the sharp corners to prevent the tool from cutting the insulation on the wires. In use this tool is forced through the slot as far as it will go without damaging the core or wires. Then the end of the tool projecting beyond the core is worked up and down to force down the wires. Care must be taken not to use force enough to bend the laminations.



When the slot opening is narrow, tools like these will help to get the right number of wires in the slot.

These tools will be found great time savers in winding almost any stator or rotor with partly closed slots.

A. C. ROE.

Detroit, Mich.

Slip Ring Motor Used As Frequency Booster

IN DIRECT-CURRENT testing it is very common to connect a low voltage generator in series with the supply to raise or lower the voltage as required for testing, such a generator or set being called a booster. Raising or lowering the frequency of a supply line is, however, not quite as common, although it can be done almost as readily and through a wide range by a simple slip-ring induction motor. Of course, most testing rooms have generators for 25, 40 and 60 cycles and the frequency of these can be regulated through a limited range by changing the speed, but when machines of 100 cycles come along for testing, as was the case with the writer recently, some other arrangement is generally required.

If the stator of a slip-ring motor is excited with, say, 60-cycle current, there will be induced in the rotor a current of the same frequency, just as though it were a transformer. The frequency, however, decreases as the rotor speeds up until at synchronous speed the frequency will drop to zero. If, instead of allowing the rotor to start up in its normal direction of rotation, it is speeded up in the opposite direction by belting it to another motor, the frequency in the rotor will increase until at synchronous speed it will be doubled, 120 cycles. For 100 cycles the speed would, therefore, have to be two thirds of synchronous speed in the opposite direction or 1200 r.p.m. on a 1800 r.p.m motor.

By utilizing the proper motor for turning the rotor, preferably a variable-speed, direct-current motor, any frequency from zero to 120 cycles can be obtained from the rings without overspeeding. The voltage can be regulated on the stator side up to the full voltage of the stator and if the rotor voltage is not high enough, it can be stepped up through a transformer. The power required to drive the rotor will depend upon the current taken from the rings, being positive above 60 cycles and negative below 60 cycles. The driving motor really

acts as a brake below 60 cycles. Where transformers are not available and the rotor voltage is too low the procedure may be reversed by exciting the rotor and taking the current from the stator, care being taken, however, not to put too much voltage on the rotor. Voltage and current of rotor winding is generally stamped on the end of the shaft instead of on the nameplate.

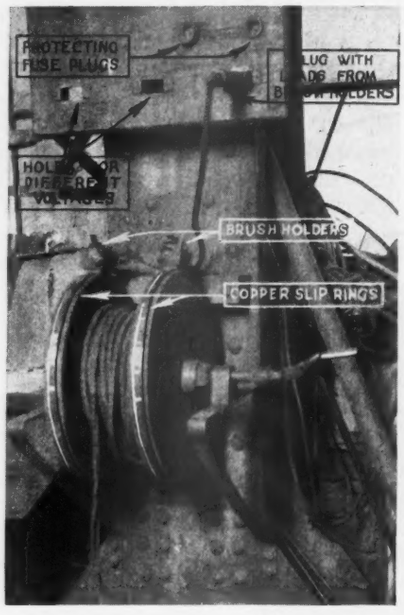
PHILIP G. BERNHOLZ.

7 William St.,
East Orange, N. J.

Test Line for Use in Motor Repair Work

IN THE small electrical repair shop a "lighting out" circuit is often required. The one shown in the accompanying illustration is made so that it can be used anywhere on the shop floor. An old wire reel was mounted on brackets, as shown, and fitted with a crank for reeling up the cable.

About 50 ft. of two-conductor No. 16 "hard service" cable is used for the leads. The inside ends of the leads are attached to the slip rings, which are placed around the circumference of the ends of the reel. These slip rings are made of copper strap, held in place by screws inserted through countersunk holes in the copper. A pair of brushholders with brushes are mounted on a wooden support attached to the iron column and are set to bear on the rings.



Construction of the test line with reel for service in repair shop.
Enough two-conductor cable should be placed on the reel to reach any part of the shop where testing with low voltage is required. Lamp banks in series with the holes, and protecting fuses, are mounted on the upper portion of the plug board. An old wire reel can be used to make an outfit of this type.

Connection is made from the brushholders to the supply by a short length of cable and a wedge-shaped connector. This connector can be plugged in any one of three holes. The first hole supplies 110 volts a. c., the second has 250 volts d. c., and the third 250 volts d. c., in series with two lamps. Additional lamp sockets are provided so that more pairs of lamps can be connected in parallel to give a larger current when required. The apparatus can be used for "lighting out" control circuits, giving low-voltage ground tests, and for various armature repair work.

A. J. W.

Indiana Harbor, Ind.

The test line is being used here for a low voltage ground test on a partly finished armature.
The wire on the test reel has been unwound enough to reach the partly completed job still mounted in the lathe. In this particular case the lathe is about 30-ft. from the location of the test line reel.

Rewinding a Two-Phase Motor for Three-Phase Operation

CHANGING a two-phase, six-pole motor to operate at the same speed on three-phase energy of the same voltage and frequency was recently accomplished by the writer by rewinding in the method here outlined. The motor was a 100-hp., 220-volt, two-phase, 60-cycle, six-pole, 1,120-r.p.m. squirrel-cage induction motor. The two-phase winding consisted of ninety-six coils, in two layers with eight turns of three No. 10 double-cotton-covered wires per coil, pitch 1 to 12, connected six-parallel, eight coils per group, in twelve groups. The total two-phase winding in series was good for $2 \times 6 \times 220 = 2{,}640$ volts, with a chord factor of 0.88185. The voltage per phase for three-phase would be $2{,}640 \div 3 = 880$ volts per line for a series-delta connection. Although $880 \div 220 = 4$, a four-parallel connection cannot be had on a six-pole motor. A two-parallel connection, however, would give $880 \div 2 = 440$ volts, and to get 220 volts the number of turns per coil could be decreased 50 per cent and the cross-section doubled. The equation $2{,}640 \div 3 = 880$ does not take into consideration the distribution factor, which is 0.905 for a two-phase and 0.995 for a three-phase motor. Taking this into account, the corrected three-phase voltage would be $(0.995 \div 0.905) \times (2.640 \div 3) = 1.0552 \times 880 = 928.57$ volts, and with a full-pitch winding the three-phase voltage would be $928.58 \div 0.882 = 1{,}052.81$ volts.

A chord factor was accordingly chosen which would decrease the voltage to 880. This chord factor is $880 \div 1{,}052.81 = 0.8349$, which is the sine of the angle 56° 36′, nearly. Therefore, the coil must span $2 \times 56° 36' = 113°$ in electrical degrees. But one slot spans $180° \div$ (16 slots per hole) $= 11.25°$. Therefore the coil pitch will be $113° \div 11.25° = 10$ slots, or a pitch of 1 to 11. This pitch gives an exact chord factor of 0.83147; thus the three-phase voltage $= (1{,}052.81 \times 0.83147) \div 4 =$ 218.84 volts, which is close enough

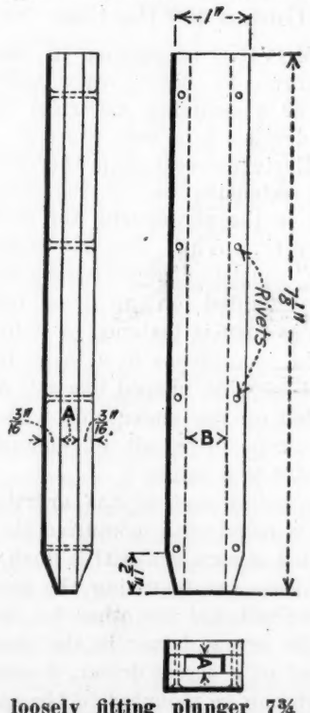
to 220 volts for satisfactory running. The stator was therefore rewound for three phases with ninety-six coils having four turns of six No. 10 double-cotton-covered wires in parallel per coil, pitch 1 to 11, connected two parallel delta, thirty-two coils per phase, and sixteen coils per circuit. The grouping for ninety-six slots, three phases and six poles was odd. A top-to-top connection was used, the coils being grouped and arranged as follows: 6-5-5, 5-6-5, 6-5-5, 5-5-6, 5-6-5.

After this change had been made the motor operated satisfactorily.

Detroit, Mich. A. C. ROE.

Device to Drive Slot Wedges Into Place

MOTOR wedges are easily held in position for driving them into the slots by means of a device developed in a New York repair shop. The drivers are made of five pieces of cold-rolled steel with the front end tapered to permit of working in restricted spaces. When using the driver the wedge is placed in the chamber with ¼-in. projecting. The plunger is inserted from the rear



A loosely fitting plunger 7¾ in. long fits into this wedge driver

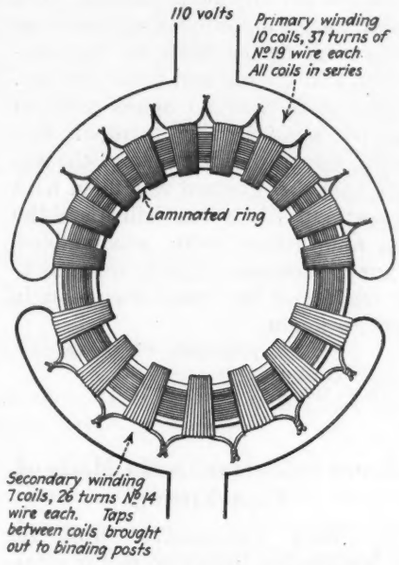
and driven by a rawhide mallet. The sizes most used have *A* and *B* dimensions respectively 1/16 in. and 7/16 in., 5/64 in., 7/16 in. ⅛ in. and 9/16 in.

C. A. JOHNSON.

Bronx, New York City.

Bell-Ringing Transformer Made from Coil of Old Arc Lamp

IN THE plant where the writer is connected with the electrical department over one hundred arc lamps were discarded some time ago for other forms of modern lighting equipment. This caused a question as to what disposal to make of them.


110 volts
Primary winding 10 coils, 37 turns of №19 wire each. All coils in series
Laminated ring
Secondary winding 7 coils, 26 turns №14 wire each. Taps between coils brought out to binding posts

How coils were added to old arc-lamp transformers to make bell-ringing transformers for 110-volt primary.

One company offered three dollars for the old lamps as junk, but we tore one down, weighing the iron, copper and zinc, and found we could use the metal in our own plant at a greater value than three dollars. This we did with some, saving the globes. With others we saved the small ring transformer and added enough coils to make ideal bell ringers for 110-volt lines. These we put on our elevators and at other places where low voltage could be used. The slot in the ring through which the coils were passed was plugged with three strips of iron after the coils were in place. The transformer was then given several coats of shellac. It was placed in a sheet-iron box which was then filled with plaster of paris. Some of the transformers were grounded at first but they dried out in a few days. The primary leads were taken in through porcelain bushings and several secondaries were brought out to brass screws on a piece of fiber board mounted on the side of the box. The voltage on each post was marked near it on the fiber. These voltages were determined by a voltmeter reading.

Sheet-metal ears were soldered to the bottom of each box to allow it to be fastened to the wall or a supporting board.

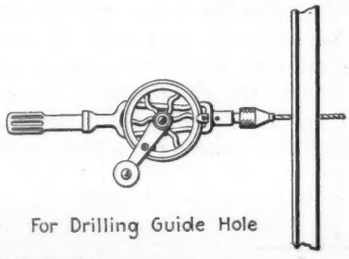
We sold a number of the arc lamp globes to company employees for holding gold fish. The globes were mounted for this purpose by placing them in a plate of plaster of paris.

Batavia, N. Y. N. S. DAVIS.

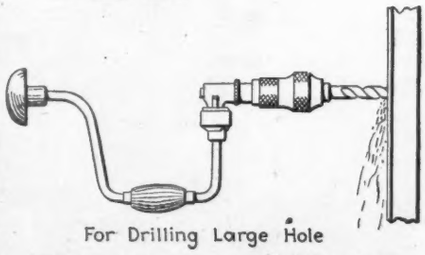
How to Make Speed in Drilling Slate

WHEN erecting a switchboard it may be necessary to drill some extra holes. This is not a difficult nor long job if properly done. If an attempt is made to use a drill of any fair size it will usually be found difficult to push it straight through. It will invariably sheer off to one side, due to hard veins in the slate. The surest way is to first drill all the way through with a small hand drill, about one-eighth in. diameter. This small hole will guide the large drill and allow it to cut faster, as its point has no obstruction to cut through.

Drills for slate should be sharp. Use the small sizes in a little geared hand-driller and the large sizes (above three-eighths in.) in a common carpenter's brace. The small hand-driller should be worker very fast and lightly, but the large drills



Use little pressure and turn fast



Use much pressure and turn slow

should be worked slowly and with great pressure. The drills will then retain their sharp edge and will not heat, but will cut rapidly and cleanly.

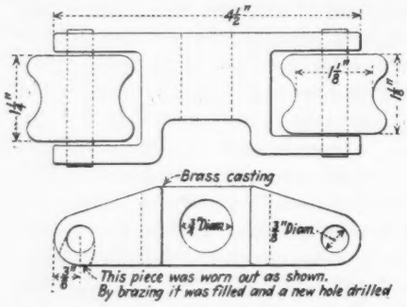
Drilling slate at high speed with the aid of cooling water is not good

practice as the drills will heat and lose their temper, and the slate dust will form into a thick mud right at the start. Drilling slow and hard is the best and quickest method, care being taken to ease up on the pressure when the drill is about to break through, to prevent a large scale from breaking away at the back.

New Britain, Conn. H. S. RICH.

Crane Trolley Quickly Repaired by Brazing

NOT LONG ago the trolley of a 15-ton crane located in the shipping department of a large Eastern manufacturer refused to function one afternoon during the rush of getting a shipment loaded to connect with the evening train. By resorting to brazing the trolley was quickly and permanently repaired. Within forty minutes after the damage was reported to the maintenance department the crane was again in service.



When the indicated section of the casting wore through, it was filled by brazing and a new hole was drilled.

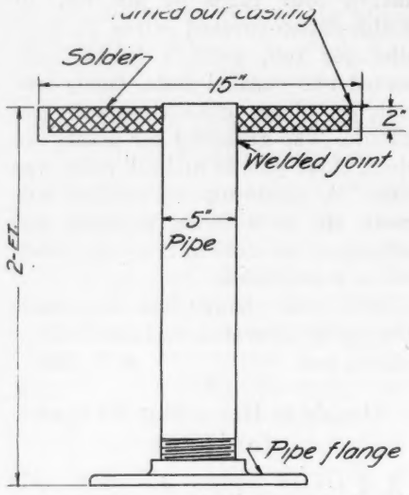
The trolley consists of a brass casting forming a double yoke. Two rollers which make contact with one of the trolley wires were set in these yokes. The rollers were fitted to brass pins on which they were just free to turn. The pins were riveted over on the ends to fasten them to the yoke. It happened that one of the rollers became fast to its pin so that it would not turn. As the pin was not riveted very tightly to the yoke both the pin and roller turned. In a short time the yoke was worn out, as shown by dotted lines on the diagram, and the pin and roller fell out. Since there was no spare part on hand it was necessary to repair this part. By means of brazing, the entire hole thus formed was filled with brass; a new hole was drilled and the pin and roller were reassembled. Thus a permanent repair was quickly made and the crane was soon in service again.

EUSTACE C. SOARES.

Electrical Engineer,
Orphuls, Hill & McCreery,
New York City.

Rotor-Soldering Outfit Made of Pipe Fittings

A VERY inexpensive outfit for soldering induction motor rotor-bars into the end rings has been in use for some time by the Old Dominion Copper Company, Globe, Ariz. It consists of a 2-ft. length of 5-in. pipe having a flange as a base at the lower end and a turned-out casting 15-in. in diameter welded to the upper end to serve as a cup for the solder as illustrated. The cup is filled with hard solder and heated with four gasoline blow torches. The time required is from one-half to three-quarters of an hour. The shaft of the rotor extends down into the pipe when the rotor bars are being soldered.



Inexpensive outfit does good work in soldering rotor bars.

STEPHEN TILLMAN.

Chief Electrician.
Old Dominion Copper Company.
Globe, Ariz.

Motor Screw Driver Increases Output 400 Per Cent

REMOVING or putting in small screws by hand, when taking down or assembling electrical and other devices, is a slow process. A large Eastern repair shop, therefore, makes extensive use of the device shown in the photograph for doing this work. This "electric screw-driver" consists of a sewing machine motor mounted on an iron base, which in turn is fastened by 1 in. x 3/16 in. iron straps to a ½-in. iron strip 4-in. wide, shaped like a U and provided on the under side with a wing screw to permit of clamping the outfit to a bench.

The pulley end of the armature shaft is fitted with a knurled sleeve provided at each end with a flush set screw, one for fastening the sleeve to the shaft and the other for holding the screw driver in the sleeve. Instead of a screw driver, a socket wrench can be mounted in the same way and used for putting on or removing small nuts. With the aid of this device an operator can do at least four times the amount of work that could be done by hand.

Screw-driver mounted on shaft of small motor by means of a knurled sleeve.

Better ways to transport and handle raw and finished parts in and around the works will be discussed in this section.

Portable Elevator Cuts Labor in Half in Unloading Bagged Material from Cars

TWO PIECES of equipment are used in practically every material handling operation at the Chicago plant of the U. S. Materials Company—a hand truck and an Economy portable elevator. The plaster, which makes up the bulk of the stock, comes in 100-lb. bags, although some other supplies are handled in barrels. Here, as in most warehousing operations, the work consists of receiving, storing and shipping, and in each the hand truck is used to carry and the portable elevator to lift.

The floor of the plant is below car door or motor truck level, which makes it necessary to lower or raise all materials received and shipped. This plant has only one receiving platform and so could unload only one car at a time before the portable elevator was installed. Under the old method of handling bags of plaster a hand truck was wheeled into the car and the bags piled upon it. These were pushed out of the car and across the receiving platform to an elevator which lowered the truck to the ground level. The truck load was then taken to the proper section of the one-story warehouse and stored.

To pile the bags to the 9-ft. ceiling required two gangs of men—one gang on the floor and another on the pile—each gang passing the bags on to the next. Taking bags out to fill an order also required extra help, except when the pile was low. Extra handling was necessary in loading the bags on a motor truck or wagon as the men had to lift the bags from the hand truck to the wagon and then the driver picked them up and carried them forward as he loaded his truck.

The 1¼-ton portable elevator shown in the accompanying illustrations cut out half the work. With it any car on the siding can be unloaded whether it is "spotted" at the unloading door or not. The portable elevator is pulled up in front of the car and the steel platform unfolded, as shown by the dotted lines in the illustration at the right, with one end to form an inclined runway and the other resting in the car doorway. The elevator platform is about 30 x 40 in. and is large enough to hold a hand truck, which is pushed up the incline onto the platform and raised to the level of the car door by a 4-hp. motor. Because of the gritty nature of the material the motor is enclosed. One of the numerous 220-volt sockets placed around the warehouse can be reached by a 50 ft. extension. The hand truck is pushed into the car and loaded, then pushed out onto the platform, lowered and taken to the warehouse. The operation is repeated and the car unloaded without having to carry the bags to the car door and then loading them on the hand truck, as was necessary before when an extra car had to be unloaded.

This elevator also enables one gang to pile the bags to the 9-ft. ceiling in the warehouse instead of requiring two gangs. The bags are piled six high on the floor from the hand truck. Then the portable elevator raises the loaded truck to the proper height for the man to unload while standing on the pile. This

The labor saved more than pays for this machine each year.

Bags of plaster and other material are handled with one-half the labor by this power-operated portable elevator, which is used for unloading cars, for piling the bags to the ceiling and for reloading on cars or motor trucks. A 50-ft. extension cord enables the elevator to connect up to any of the numerous outlets in the plant or yard. The Economy Engineering Co., Chicago, Ill., manufacture the equipment.

eliminates an extra handling and an extra man.

When filling orders the motor trucks, wagons or cars are loaded in almost the reverse operations of storing and unloading, with the elevator placed at the curb. One end of the platform rests on a wooden "horse" about wagon level high. A wagon or truck is backed up to this and the loaded hand trucks are lifted by the elevator and pushed across the steel runway into the wagon. The driver then simply lifts the bags of plaster off the hand truck and loads them without any carrying. Meanwhile, the warehouseman has gone back for another load. The wagon is loaded more quickly, which is a big item when several are waiting, and also with less than half the work.

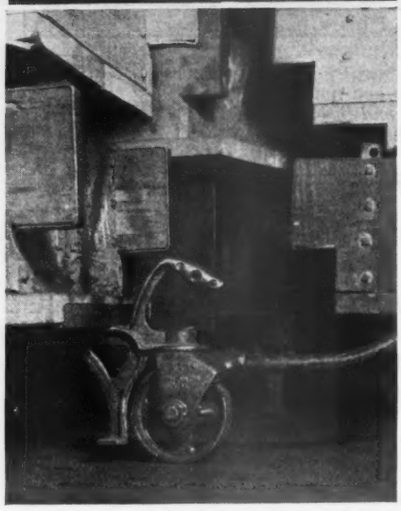
Simply pulling down on the steering handle, shown in the illustration at the left, raises the front end of the elevator from the floor so that one man can pull it around like a hand truck. When the handle is released it flies back into a vertical position out of the way and the elevator becomes stationary, as it rests on the frame instead of the two front wheels. The uprights of the machine are hinged and can be folded over by simply pulling out a few pins, so that it can go through low doorways.

Although the platform of this machine can be elevated only about 4½ ft., other machines are made which elevate up to 30 ft. and have a capacity of five tons. They may be either hand or power driven.

The big saving is through the lessened labor required due to the decreased handlings. It would easily take one or two more men if it were not for the tiering machine. In that way it more than saves its cost every year. The expense of operation is low, as power is used only during the few seconds of the lift; the platform is lowered by gravity.

Handle with Wheel and Hook Used to Move Two-Wheeled Trucks

THE illustrations show how a small wheel fitted with a handle and a hook is used to move small two-wheeled box trucks employed in the transportation of materials into or out of the stockrooms of the Studebaker Corporation of America, South Bend, Ind. The front end only of truck is shown; at the top the foot attached to the truck is resting



Hook on wheel housing entering the hole in the truck fitting. When the handle is pulled forward the foot is raised and the front of the truck rests on the wheel.

on the floor with the hook on the upper part of the wheel housing just entering the hole in the fitting attached to the under side of the truck body. The handle shown as a part of the fitting is used when connecting several trucks together in a train to be moved by a tractor.

When moving the trucks by means of this device the hook is inserted in the hole in the manner shown in the illustration. Then the handle is straightened into the position that it would normally assume when pulling the truck. This movement lifts the foot of the truck off the floor and allows the hook to make a full engagement with the round hole in the truck fitting, as in the lower cut. Flat surfaces on the top of the wheel housing and on the bottom face of the truck fitting form the bearing surfaces on which the weight of the load is carried.

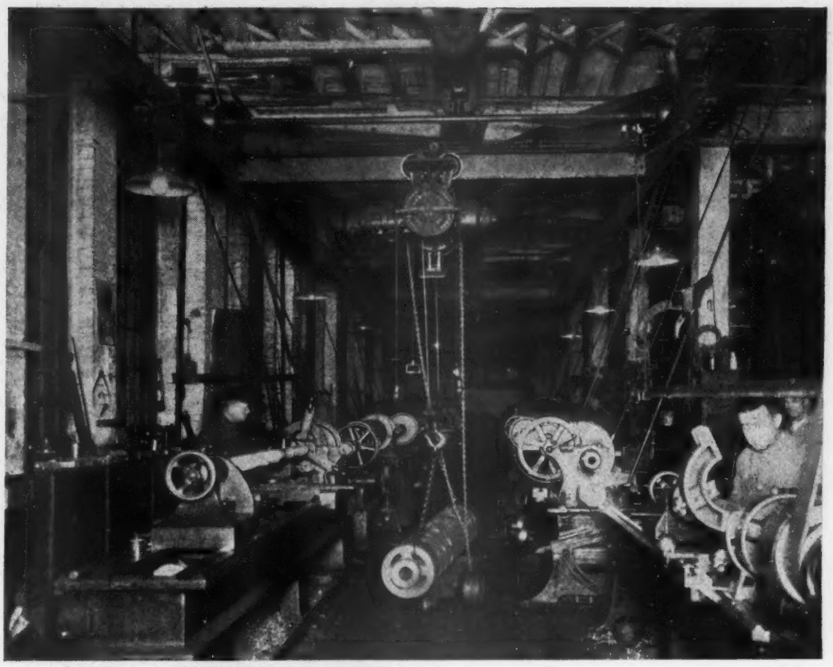
With this wheel in place the truck is supported on three wheels and can be moved with ease. The front wheel may be moved in any direction, to turn corners and so on, and will stay in engagement as long as the handle is not raised. When it is desired to disengage the front wheel it is only necessary to lift up on the handle, allowing it to go back to the position as shown above. Then the hook rocks out of engagement and the front end of the truck is lowered until the foot again rests on the floor. In this position the truck is more or less firmly anchored by the friction between the foot and the floor and hence is not liable to be accidentally moved.

Installing Overhead Cranes in Shops with Low Ceilings

PLANTS which have been built for a number of years often present some of the biggest material handling problems. Many times the type of construction limits the equipment which may be installed. This was the problem which confronted the Goss Printing Press Co., Chicago, where a battery of 14 lathes are used for machining the cylinders for the printing presses. These cast-iron cylinders are about 7 ft. long and 15 in. in diameter and weigh before turning about a thousand pounds. The low ceiling with its shafting and belts interfered with installing a bridge crane to lift the cylinders in and out of the lathes or to carry them from one machine to another. The old practice was to remove the machined cylinders and hoist new castings into position with a chain hoist. This required two men and the operator and also tied up the lathe for a considerable length of time. This idleness was expensive.

The problem was solved by lining up the lathes in two rows and moving the countershafting to a line outside the row of lathes as shown in the accompanying illustration. Two 8-in. I-beams were suspended from the ceiling below the shafting and belts and form a runway for a floor-operated power-driven traveling crane, which carries a 1½-ton Shepard electric hoist on about a 15-ft. span. This crane has power travel as well as lift. A pair of overhead trolley wires supplies the power.

Now a cylinder may be taken off a lathe and another put on by one man and the operator in about five minutes. When another lathe is not ready the cylinder is placed on the



Two men do three men's work here
Because of the low ceiling it was necessary to rearrange the lathes and countershafting so that a crane could be installed below the line-shaft and belts. This not only speeds up lifting the cast-iron cylinders in and out of the lathes, but enables fewer men to do it. The Shepard Electric Crane and Hoist Co., Montour Falls, N. Y., made the installation.

two-wheeled dolly truck shown in the foreground, which is also used to carry the cylinder to storage or other parts of the shop not served by the traveler.

In several other parts of the shop Shepard electric hoists are used, either on I-beam trolleys suspended from the ceiling or on swinging jibs supported from the pillars, to feed one or more machines. Assembly of the presses is also speeded up by sixteen 2½-ton Shepard cranes, one to each assembly floor. These cranes have a maximum lifting speed of forty feet a minute, as careful adjusting is more necessary than speed.

Heavy Loads Hauled by Battery-Driven Electric Tractors

IN THE plant of the Crane Company, Chicago, Ill., great numbers of iron fittings and other metal parts have to be moved between the foundry, finishing departments and the stock rooms. The distance which these pieces have to be moved is often considerable, and to meet this condition in an economical manner a number of battery-driven tractors have been placed in service, hauling single trucks or trains of trucks loaded with material-containers. The illustration shows a train of four trucks loaded with fittings being moved inside of the buildings.

Each tractor is fitted with a set of 40 A-6 Edison storage cells installed under the driver's seat and in the box at his back. Spare batteries are available so that in case of exhaustion a new set may be slipped into place and the tractor kept in service for an almost indefinite period. The motor used is rated at 40 volts and 50 amperes, with a speed of 1000 r.p.m. With this equipment the tractor has a maximum speed of 14 miles per hour. Loads up to six tons are handled by a single tractor, the customary full load usually being made up of a five or six-car train.

The use of low-hung truck platforms makes it easy to load the individual cans onto the truck, the ease of loading being increased by the use of tall cans. Those used with this equipment may be tipped to one side and then "walked" onto the truck platform with comparatively little effort. Finished fittings are dropped into the cans at the machines, where they are put through process, thus reducing handling.

In addition to the trucks a large number of boxes, raised from the floor on legs, are used in connection with the material transportation equipment. These raised boxes are picked up on small trucks provided with an elevating platform which, when lowered, goes under the bottom of the box.

This battery-driven truck hauls a load of six tons
This is one of a fleet of machines which solves transportation problems in the Crane Company's plant, Chicago, Ill. The maximum speed of these tractors is fourteen miles per hour; a forty-cell, A-6 size Edison storage battery supplies the motive power.

This conveyor cut the labor cost in half.
Repair parts are taken from the stock bins at the upper left side of the illustration and carried by a belt conveyor to the inspectors' and packers' benches. The packed boxes are then transferred to the gravity conveyor at the right and pass down steel slides to the conveyor at the lower right, which carries them to the shipping room. Ball tables facilitate the transfer or shifting of heavy boxes.

Unique Conveyor System Reduces Labor Cost in a Packing and Shipping Department

THE service parts shipping department of the Hudson Motor Car Company, Detroit, Mich., is called upon to draw out of stock and prepare for shipment a large volume of parts for replacement and repair work. The problem of how this material could best be handled in its journey from the stockroom to the shipping platform was finally solved by the installation of a conveying system, designed by The Dow Company, comprising belt and roller units supplemented by steel slides.

Small parts called for in an order are collected in a steel pan from the stock bins shown in the left foreground of the upper illustration. When all of the parts have been collected the pan is placed on a belt conveyor which runs closely parallel to and just below the roller gravity conveyor shown on the left. This belt conveys the pan to the order inspectors, who work behind the steel bins shown at the left in the distance. After the inspectors check the parts and see that the order has been properly filled, the pan is placed on the upper line of the roller conveyor, where it is passed along to the packers.

The lower deck of the gravity conveyor, shown on the left in the distance, is used for returning empty pans to a central point. The lower run of the belt conveyor is also used to carry pans from the central point to the clerks working in the stock bins.

Parcel-post orders are packed right on the gravity conveyor near the inspection bins, where they are weighed. The order is tacked on the outside of the box, which is then transferred to the gravity conveyor shown in the right distance; from this point it travels by gravity to the open hatch and down to the first floor on a steel slide.

Express and freight orders are packed on the bench in the left foreground and travel to the first floor through the open hatch shown in the right foreground. All of the heavier parts are assembled and packed on a gravity conveyor running on the floor the full length of this building, which is about twice the distance shown in the photograph. This line curves around the open hatch in the immediate foreground and delivers the boxes on to the first ball transfer table; here they can be easily pushed over in line with the open hatch and dispatched down the slide to the first floor.

The discharge ends of the two steel slides from the second floor are shown in the lower illustration. The single line of gravity conveyor from the distant slide brings the parcel post packages. These are dispatched from the second floor in large wooden tote boxes, from which they are taken by clerks who prepare them for the mails. These packages are usually taken off the line before they reach the ball table shown in the foreground, but, if necessary, may be left on and transferred to the double line conveyor at the right. This double line gravity conveyor receives freight and express packages from the near steel slide and carries them to a point where they can be transferred to motor trucks.

These transfer tables consist essentially of a number of rows of steel balls approximately 1¼ in. in diameter spaced on about 6-in. centers and supported on cup-shaped standards. A steel plate with holes slightly smaller than the balls, but correspondingly spotted, forms the top of the table and rests on supports which are low enough to permit the balls to project through slightly.

With the aid of this conveyor system 27 men are now doing the work that formerly required twice that number, with a resultant saving of many thousands of dollars a year

Wiring for Motors

(*Continued from page* 130)

In applying this formula to a motor circuit, it may be necessary to use the starting current of the motor for the value *I* in the formula. This will usually not be necessary when only one motor is considered, as a small drop in voltage will only make the motor start slower, which will not be harmful provided it is not heavily loaded. The voltage drop, however, may lower he speed of other motors, which in some cases would be undesirable.

Sizes of Mains Necessary for Alternating-Current Motors

The size of mains necessary for alternating-current motors is figured in the same way as those for direct-current motors, allowing, of course, for the greater starting currents required. The mains must be made large enough to carry the largest load which will be put upon them at any one time. This load may be figured from tests on similar installations, but where there is nothing on which to base the load, the full-load current of other motors should be added to the starting current of the largest one. For instance, take the following example of 5-hp., 10-hp. and 15-hp. motors operating at 110 volts and 1,750 r.p.m.:

	Amp.
5-hp. motor (110 volts) has full-load current of	27
10-hp. motor (110 volts) has full-load current of	52
15-hp. motor (110 volts) has full load current of 76 amp. Multiplying this by 200 per cent for starting current gives	152
This makes a total of	231

By looking at the wire table it is found that 250,000 circ. mils will carry 250 amp., and therefore will be large enough. That is, of course, provided that the voltage drop will not be too great, and this will be figured as shown in the next paragraph. If the full-load current of this motor had been 30 amp. or less, it would have been multiplied by 250 per cent for the starting current instead of 200 per cent.

How to Figure Voltage Drop on Alternating-Current Circuits

The size of wire which will give a certain voltage drop on an alternating-current circuit is figured by the following formula:

Area of circ. mils $= (C \times I \times L) \div e$.

C=constant (see Table A).

I=current.

L=distance in feet (one way).

e=voltage drop.

Table A: Values of constant C for various power factors and types of alternating-current circuits:

	Power factor in per cent				
System	100	95	90	85	80
Single-phase	22	24	27	30	34
Two-phase (four-wire)	22	24	27	30	34
*Two-phase (three-wire), outside wires	22	24	27	30	34
Three-phase (three-wire	20	22	25	27	30

*For a common return take wire 1.42 times as long as outside wires.

The power factor to be used when applying this table may be taken as 95 to 100 per cent for lighting only, 85 per cent for lighting and motors and 80 per cent for motors alone running as somewhere near full load. For very low loads the power factor may be much lower, and some knowledge of operating conditions must be obtained.

Suppose, for instance, it is desired to find the size of wire to use on a three-phase load of 100 amp. in each leg, running a distance of 100 ft. and with a 3-volt drop. Then the constant C from Table A for 100 per cent power factor equals 20, and the formula will read as follows:

Circ. mils $= (20 \times 100 \times 100) \div 3 =$ 66,667 circ. mils. By consulting the wire table No. 2 wire is found to be the proper size.

Where only one motor is connected to a circuit a small voltage drop while starting will not affect the motor if it is not heavily loaded. However, if other motors are on the circuit the voltage drop caused by starting one motor may slow up the others, and in such a case the starting current should be added to the running current of the other motors and the total used in this formula.

Size of Wire for Motors on Services Having High Peak Loads

The wire must be large enough to carry to rated amperes multiplied by the percentages below.

	Percentages of Name-plate Rating				
Service	5 min. rating	10 and 15 min. rating	30 and 60 min. rating	2 hour rating	Continuous rating
Operating values, raising or lowering rolls	110	120	150	200	250
Hoists, rolls, ore-handling and coal-handling machines	110	115	120	150	170
Freight and passenger elevators, shop cranes, tool heads, pumps, etc.	110	110	110	120	140
Rolling tables	110	120	135	180	200

How to Wire for Motors Doing Special Duty

These tables all apply to motors which start under fairly light loads and operate under ordinary continuous-duty service. Where motors start under heavy loads, or a load with high peaks, or at variable speeds, the values from the tables may not apply. The values are not high enough for motors which start under practically full load or greater, such as those operating pumps or compressors starting under pressure, or machinery having heavy fly-wheels. The high values of starting current which will be drawn with such motors must be taken into consideration when installing the wiring, switches and fuses. The current values may be determined by tests or by consulting the manufacturers of the driven machinery.

For motors having intermittent duty or variable speed, the wire size must be selected according to the tables of Rule No. 8 of the National Electrical Code, which are shown in the wire table in this article. For this service conductors having rubber insulation cannot be protected by fuses rated in accordance with Table C (other insulation).

The size of conductor connecting slip-ring motors to resistance grids must be based upon the current in the rotor circuit, and this value may be obtained from the name plate of the machine. Rotor current will ordinarily be between 25 per cent and 100 per cent of full-load stator current.

Larger Wire Must Be Used For Low-Speed Motor

The tables give wire sizes for standard motors (1,800 to 1,200 r.p.m. Where low-speed motors are used the wire, fuses, switches, etc., must be of a higher rating. Where speeds of 600 to 900 (*continued on page* 154)

Things Crane Inspector Looks for

(*Continued from page* 118)

bars and slots in bars cleaned with a hacksaw blade to receive the coil leads for soldering. Shorted bars are tested with 110 volts in series with one or two 100-watt lamps. Tests for bars are made with 250 volts after being tried with 110 volts and two lamps in parallel and connected in series with test points.

Slot Insulation.—The armature slot insulation used consists of empire cloth and leatheroid. It has been standard practice in our plant to insulate the slot in preference to the armature coil as it is much faster and only a small amount of extra insulation is used by this method. The empire cloth is placed next to the coil because in coil burnouts or armature burnouts or where the heat is excessive for any reason, empire cloth when used next to core laminations will bake in, requiring considerably more time to clean the armature core for rewinding than when empire cloth is placed next to the coil. This also applies to alternating current windings.

On page 117 a winder is shown placing coils in an armature core. The long coil leads are for wave winding with one quarter throw in each direction from point of coil. The coil is then connected upon the half + or — one. After the armature is wound, soldered and banded it is again varnished to close any cracks that have been made in the varnish when winding and again baked.

Soldering Leads.—In soldering leads to the commutator, it is sometimes helpful to tilt the commutator slightly downward to prevent solder from flowing backward through the slot in commutator bar and forming a short back of the commutator. Never use soldering salts, such as are used for line work, in soldering a commutator. Do not use muriatic acid and zinc or sulphuric acid, as they will cause short circuits between the bars. Use common soldering paste or other preparations that have been tested and are known to be free from any possible corrosive effects.

Complete Armature as a Spare.—On page 117 is shown a completed armature ready to go upon a crane in case of breakdown. This armature has two small armature bands in addition to those which the factory uses on type K-4 d. c. armatures. These two small bands are applied one at each end of the armature core laminations. This was done because coils would raise above the core at these corners and strike the field coils of the motor. This in time would ruin the armature winding and make repairs upon field coils necessary. The addition of these two small bands has entirely eliminated this trouble.' As may be seen from this illustration., the armature is assembled with both front and rear bearing housing, pinion and brake hub. The pinion and brake hub are both securely keyed to the armature shaft. This method of keeping the armatures was resorted to because better work can be accomplished in much less time upon the floor than if left to be done after the armature is hoisted upon the crane. Also less time is required before the crane can again be put in service. Better fitting of keys is obtained and when the pinion or brake hub is to be removed less trouble is experienced.

Approximate Armature Rewinding Costs for a 220-Volt, 7.5-Hp., K-4 Armature

Making the coils:

4 hr. winding coils at $0.625 per hour	$2.50	
15.25 lb. magnet wire at $0.25 per lb.	3.81	
15 minutes dipping coils, first dip, at $0.625 per hr.	0.16	
24 hr. baking 1.0 kw. power consumption per hr. for 24 hr., figuring at $.05 per kw. hr.	1.20	
3.5 hr. sleeving coil leads at $0.625 per hr.	2.18	
68 ft. sleeving at $0.005 per ft.	.34	
½ hr. shaping coils at $0.625 per hour	.32	
15 min. second dipping	.16	
24 hr. baking, 1 kw. power consumption per hr. for 24 hrs., figuring at $0.05 per kw. hr.	1.20	
Taping coils 4 hrs., at $0.625 per hr.	2.50	
240 ft. .008 cotton tape	.50	
Total		$14.87

Rewinding the armature:

1 hr. stripping armature at $0.625 per hr.	$0.625	
1¾ hr. cutting slot insulation and insulating core at $0.625 per hr.	1.09	
4 hr. winding in coils at $0.625 per hr.	2.50	
1 hr. putting down leads at $0.625 per hr.	.625	
1½ hr. banding, at $0.625 per hr.	.94	
1½ hr. helper's time banding at $0.50 per hr.	.75	
½ hr. testing at $0.625 per hr.	.32	
½ hr. painting last time, at $0.625 per hr.	.32	
8 sq. ft. "Leatheroid" insulating core	.15	
8 sq. ft. "Empire" cloth insulating core	.30	
		7.62
Grand total		$22.49

At the present time the brake hub and pinion are assembled upon straight shafts. In the future, however, all shafts will be turned with a taper and all brake hubs and pinions bored with a tapering fit and keyed with a threaded nut upon the ends of the armature shaft. It is also the writer's intention to carry upon each crane a spare armature assembled with its required brake hub and pinion for each size motor operating that crane. The armature will be wrapped in canvas and placed in a box which may be locked. The crane repairman will have a key that will open the box should an armature be required. This will eliminate the time required to secure an armature from the store room, carry it to the defective crane, and hoist it up.

Armature Rewinding Costs

In the accompanying table of costs, no allowance is made for varnish and it should be noticed that practically all work is done by the armature winder. Our plant buys no coils, as all that are required are made at odd moments and placed in the storeroom for use when required. The time consumed upon crane repairs last year (1921) was $0.542 per horsepower per year.

Ways to Use Structural Steel

(*Continued from page* 119.)

the bracket are 3-in. by 3-in. by ⅜-in. angles and the motor is mounted on a ½-in. plate, well out of the way of workmen.

A more usual mounting is shown in Fig. 3, where we put a 5-hp. motor on a Long & Allstatter No. 1 punch. This was a straightforward job. The motor rests on a ½-in. plate, which is bolted to 2½-in by 2½-in. by ⅜-in. horizontal angle-irons, braced by 1½-in. by 1½-in. by ¼-in. angles. The former size is used on the vertical angles required at the rear.

In Fig. 4 is shown a somewhat unusual arrangement of a 2-hp. motor drive which worked out for a 15-in. drill by suspending the motor from 1½-in. by 2-in. angle-irons with diagonal braces above composed of angles of the same size. The starting switch shown at the right is mounted on ¼-in. by 2-in. strap-iron with a 3/16-in. by 1¼-in. brace attached to the drill frame. With this arrangement, the motor is out of the way of the operator.

Extensive Signal Service

(*Continued from page* 110)

on a magneto and less often the office relays need adjusting. The watchman can tell by the "feel" of the magneto key, when a connection has worked loose. The charts also give a regular check on the operation. About five hours per month is the time required to keep the system in order.

How to Take Care of the Call System

Always keep all moving parts of central sending station oiled and free from dirt. Clean all contacts occasionally and replace worn parts before they cause trouble.

Keep bearings of the motor oiled and oil all bearings on signals and other parts of the system at least twice a year.

Do not try to repair small parts that become broken, but have them replaced. Blue prints and specifications furnished with the system should be handy for reference in case of indicated line trouble.

In case there is an indication of trouble with the call system, make sure the power for operating the system is "on," and that fuses used in connection with the system are good. Inspect the fuses on the relay panel, and in the switch between the power line and central sending station. Always make sure that the pilot lamp is properly screwed in its socket, and that it is not burned out, before trying to locate trouble in other parts of the central station.

Some Pointers That Will Prevent Troubles in a Call Signal System

[1]

Inspect all equipment every two weeks.

[2]

Keep sending plug clean.

[3]

Clean the moving parts and contacts occasionally.

[4]

Oil the motor bearings once a month and the signal bearings twice a year.

[5]

Replace worn parts as soon as noticed and before trouble develops.

[6]

Examine all connections occcasionally and make sure of good condition.

[7]

Change the oil in oil-filled relays every six months.

After the operating plug is inserted in the plug board and given a quarter turn, the signals should sound a code call corresponding to the number above the hole in which the plug is inserted. If the motor fails to start when the plug is in position, the plug is not making proper contact on the motor contact bars in the plug board. This plug must be kept free from dirt and other foreign matter at all times. The steel part of the plug should be polished with fine emery cloth when it becomes dirty. It should measure ¼-in. wide and ⅛-in. thick. If it wears a good contact is not insured. If the plug is clean and the signals do not sound correctly there may be a bad connection in the sending station.

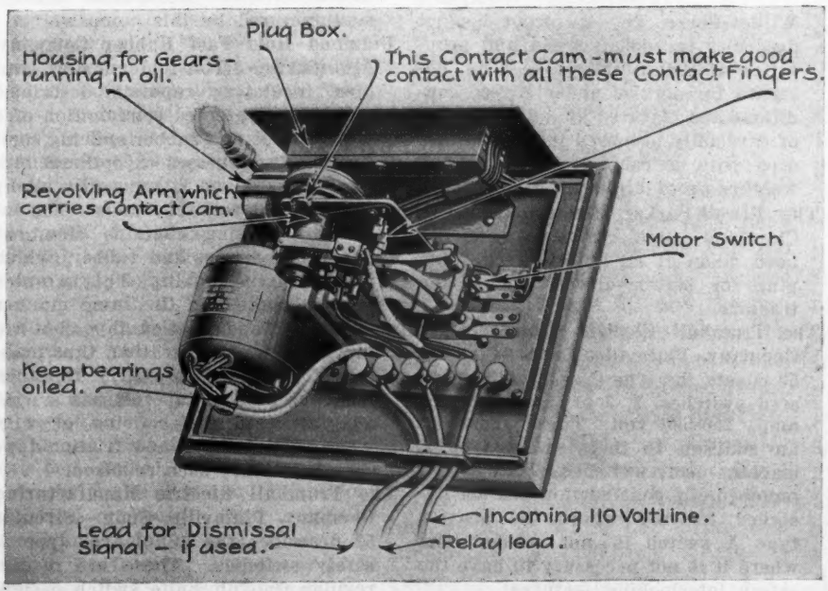
Before examining the plug board, inspect the connections from the plug board to the contact fingers on the sector plate. The wires between the plug board and the sector plate fingers may become loose, which would cause improper signals to be sounded. Also inspect the contacts on the revolving contact arm and see that the contact cams on this arm are making the proper contact on sector plate fingers.

The contact arm should return to its starting position (with the contact dog about ½ in. from the first contact) after the operating plug is removed from plug board or turned to its normal position. If the contact arm stops before the proper time, inspect the motor switch and see that the contacts of this switch stay closed until the motor-switch lever drops into the slot on the motor-switch cam, which should cause the switch to open.

The plug board should not be taken apart until all other suggestions have failed to remove the trouble, and indications point that the plug board is causing the trouble.

If the code call does not sound correctly although the correct signal is flashed by the pilot lamp, the central sending station is operating as it should, but there is trouble in some other part of the system. Each time the pilot lamp flashes, the magnets of the master relay should become energized, which should cause the contacts of the relay to close. If the magnets of the master relay do not become energized each time the pilot lamp flashes, there is trouble on the line between the "relay" lead on the central and the magnet terminals on the master relay.

If the magnets become energized each time the pilot lamp flashes, but the signals do not sound the correct code call, the contacts of the relay may need adjustment or cleaning. Operate the contacts of the master relay by hand and see that the signals respond each time the contacts


Plug Box.
Housing for Gears - running in oil.
This Contact Cam - must make good contact with all these Contact Fingers.
Revolving Arm which carries Contact Cam.
Motor Switch
Keep bearings oiled.
Incoming 110 Volt Line.
Relay lead.
Lead for Dismissal Signal - if used.

This is the mechanism of the central sending station.

of the relay are closed. This will prove that the lines from the relay to the signals are good. If the signals sound when operating the relay by hand then start a code call from the central sending station and watch the operation of the relay. If the contacts do not close as they should when the magnets of the relay are energized, make the necessary adjustments.

Master Clock Operates on 36-Volt Battery

A self-winding master clock in the Housatonic plant controls fifteen wall clocks and fourteen time clocks. Wiring for this system is of No. 18 telephone wire. The system operates on 36 volts obtained from a 36-volt storage battery kept floating across a 110-volt line in series with resistance. Water is renewed in the battery once a week. Once a month the battery is given an equalizing charge. About four hours per month of maintenance is required.

An automatic telephone and an auxiliary fire alarm are two other signal systems installed in the plant. These are kept up, however, by outside companies.

Wiring for Motors

(*Continued from page* 151)

r.p.m. are used the current will usually be about 12 per cent greater than that given in the table, and this correction should be added when figuring the wiring for the motor.

To provide for the peak loads which are encountered in certain classes of service, such as those mentioned in the following table, without over-fusing the conductors, motors will sometimes require conductors considerably larger than those specified in the tables. In the majority of cases the necessary requirements will be met if conductors are based on current values found by multiplying the name-plate rating by the percentages shown in the table on page 151.

The author wishes to state that the arrangement of a part of the data in this article was suggested by the booklet, "Wiring Data for Direct and Alternating-Current Motors," by F. D. Weber, chief electrical engineer, Oregon Insurance Rating Bureau, Portland, Ore. That booklet presents very complete data on wiring 50-deg. rise motors.

Trade Literature
you should know about

Partrick & Wilkin Company, Philadelphia, Pa.—A recent catalog describes the line of annunciators and intercommunicating telephone, fire alarm and call systems manufactured by this company. This 63-page book contains many wiring diagrams and other useful information.

Baldor Electric Company, St. Louis, Mo.—A booklet has been issued containing a description and complete data on their type R repulsion induction single-phase motors. Special features are a horizontal-type commutator, similar to that on a direct-current machine, and a centrifugal switch with only three moving parts.

Green Equipment Corporation, Monadnock Block, Chicago, Ill.—A 29-page booklet describes how Acme commutator smoothing stones are made and gives useful information on the grinding of commutators.

The Auto-Call Company, Shelby, Ohio—Recent folders call attention to the use in industrial plants of the special signalling systems manufactured by this company.

Payne-Deane, Limited, 103 Park Avenue, New York City—The first of a series of bulletins describes the Dean control, a standardized unit system of electric motor operation for valves of all sizes. The motor, reduction gearing and limit switch are housed in a water-tight cast-iron casing.

Burke Electric Company, Erie, Pa.—A booklet lists the various types and sizes of Burke electric motors which are carried in stock and also those which can be shipped on short notice.

Hazard Manufacturing Company, Wilkes-Barre, Pa.—A recent booklet describes the construction and properties of Hazard Keystone wire, designed for service under severe conditions and featured by a double layer of especially prepared insulation covered with a rubber-faced tape and weather-proof braid.

The Elwell-Parker Electric Company, Cleveland, Ohio—Announcement has been made of an improved charging plug for battery-driven trucks and tractors.

The Trumbull Electric Manufacturing Company, Plainville, Conn.—Circular 53 covers the type C externally operated switches, 2, 3 or 4 pole, 30-200 amp., 250-500 volt. These represent an addition to their safety type A machine-made switches. They are of punched clip construction and are designed for use where the heavier type A switch is not needed and where it is not necessary to have the safety interlocking features.

The Bryant Electric Company, Bridgeport, Conn.—A recent circular describes the Bryant No. 651 appliance switch plug which is being placed on the market. This will fit practically all makes of heating appliances and is featured by a toggle switch mechanism and self-adjusting springs.

Condit Electrical Manufacturing Company, Boston, Mass.—A circular describes the D-22 oil circuit breaker which has recently been placed on the market. This breaker incorporates the principles used in the present type D-12 breaker, but it designed to open circuits of higher amperage.

General Engineering and Supply Company, 160 Fifth Avenue, New York City—An announcement describes a newly developed machine for winding filament for nitrogen or argon lamps. It is self-contained and is capable of winding eighteen sizes of standard type coils.

B. F. Sturtevant Company, Hyde Park, Boston, Mass.—Bulletin 284 describes in detail the construction and special features of Sturtevant polyphase motors and includes wiring diagrams and information regarding the installation and care of polyphase motors.

The Gamewell Company, Newton Upper Falls, Mass.—A recent circular covers in detail the Gamewell F. I. P. storage battery which has been designed especially for industrial, fire alarm and police signalling systems and recently placed on the market.

Foote, Pierson & Company, Inc., New York City—Catalog 34 covers the lines of fire alarm telegraph equipment, including call boxes, recording instruments, gongs and other devices, manufactured by this company.

Diamond Hold Fast Rubber Company, Atlanta, Ga.—In a folder a new two-plex insulating tape is described, which is a patented combination of a friction tape and rubber splicing compound. It possesses exceptional tensile strength and is unusually sticky but will not soil the hands. The insulating coating contains about 50 per cent of new live rubber, which insures lasting quality. This two-plex tape is applied in the same manner as rubber and friction tape, but requires only one operation, thus making it necessary to carry in stock only one kind of tape. It has a wide adaptation in the splicing of wire where both rubber and friction tape have heretofore been required.

The Trumbull Electric Manufacturing Company, Plainville, Conn.—Circular 52 describes the "Snuf-Arc" type A safety switches. These are of the regular 600-volt knife switch design,

with the addition of a swinging moulded barrier hinged in each of the contact jaw posts and operated by an insulated connecting rod attached to each blade in such a way that when the blade leaves the jaw post the barrier instantly swings between the breaking points and effectively extinguishes the arc.

Electric Service Supplies Company, Philadelphia, Pa.—Bulletin 183 contains 62 pages of material describing "Keystone" expulsion type and "Garton-Daniels" lightning arresters for line, transformer, railway and mine protection.

Ridgway Dynamo and Engine Company, Ridgway, Pa.—Bulletin 30 describes the various sizes and types of Ridgway motor-generator sets, with many illustrations of typical installations.

General Electric Company, Schenectady, N. Y.—Indexes to the supply part bulletins and descriptive bulletins and sheets issued by this company are being distributed.

Kay Manufacturing Company, Norwalk, Conn.—The Whitney Free Floating Coupling, types B, C, D and E, are described in circular 1922. These are designed for the transmission of power between shafts which are not in alignment and are featured by a free floating center link which fits into sockets in the hubs of the coupling in such manner that it is free to rock in any direction and float laterally.

Indiana Steel & Wire Company, Muncie, Ind. — "Double Galvanized Steel Strand and Iron Wire for Electrical Transmission and Distribution" is the title of a booklet which is being distributed and gives information concerning the use of double-galvanized iron wire and steel strand for transmission purposes.

The Hayward Company, 50 Church Street, New York City.—Pamphlet 620, covering the Hayward automatic cable take-up reel and a coupler which is designed for use with either a magnet or an electric bucket has been issued.

Quigley Furnace Specialties Company, Inc., 26 Cortlandt Street, New York City—"Hytempite in the Power Plant" is the title of a booklet which discusses refractory linings and the use of "Hytempite" in power plant work as well as its uses in connection with "Carbosand" for baffles, patching boiler settings, and the like. It also gives some information on the uses of "Insulbrix."

The Uehling Instrument Company, 71 Broadway, New York City—Bulletin 220, entitled "Magnitude of the Power Plant's Chimney Loss," and bulletin 221, entitled "Relation Between CO_2 and Money Wasted Up the Chimney," have been issued. These discuss the losses in the combustion of fuel for industrial purposes and contain curves and tables of data.

Economy Engineering Company, 2645 West Van Buren Street, Chicago, Ill. —A recent booklet, "Saving Wasted Millions in Warehouses and Storage Rooms," describes how industrial plants are using Economy portable elevators to pile material several tiers high and thereby store several times as much in the same space with a big saving in labor. This equipment may be obtained up to 5-ton capacity with a lift of 30 feet. The elevator is pulled by hand from one position to another, but releasing the steering handle automatically fixes the machine stationary.

Cutler Hammer Manufacturing Company, Milwaukee, Wis.—A four-page folder, known as publication 2056, describes the C-H appliance cord recently put out by the company.

The Foxboro Company, Inc., Foxboro, Mass.—"How Far Can You Read It?" is the title of a small folder describing the easy-reading dial types of indicating thermometers. The large white figures on the black dial enable these thermometers to be read at a distance of 30 ft.

Erie Electrical Equipment Company, Johnstown, Pa.—Erie fittings and devices are described in a loose-leaf catalog recently issued.

Beardslee Chandelier Manufacturing Company, 216 South Jefferson Street, Chicago, Ill.—Two interesting catalogs are being distributed; one, S-6, a book of 128 pages, covers its complete line of "S," "C" and "Baby Denzar" lighting fixtures; the other, D-7, describes its commercial lighting equipment for store, office and school lighting.

Sangamo Electric Company, Springfield, Ill.—Alternating current watt hour meters, single-phase and polyphase, are described in Bulletin 55. The construction characteristics, adjustments, methods of installing, testing and connection diagrams are described and illustrated.

Marble-Card Electric Company, Gladstone, Mich.—Bulletin 200 describes in detail the special mechanical and electrical features of the type M. C. direct-current motors manufactured by this company.

A Correction

This opportunity is taken to correct an error in the February issue of the ELECTRICAL REVIEW AND INDUSTRIAL ENGINEER. A picture marked *B* on page 72 and the one showing motors driving looms on page 70 are from installations at the Brookside Mills at Knoxville, Tenn., and not from the Riverside and Dan-River Cotton Mills at Danville, Va. The former installation was designed by F. P. Sheldon & Son, Providence, R. I., while the latter was supervised by Lockwood Greene & Company, Boston, Mass.

Inspiring Confidence and Responsibility

(*Continued from page* 133)

curtailed production, lends itself especially to selecting the personnel of an efficient and well-ordered electrical organization. With the departmental forces cut to the quick, no superfluous help has been retained and the men remaining on the job are essentially capable men. These men have been culled and selected with regard to their adaptability for the job at hand, and they should be employed in the reconstruction of the full-time organization as the "key" men of the structure. Around them may then be grouped less experienced men coming into the organization. They will develop as the manufacturing program expands and eventually take the places of "key" men who leave.

No organization can do justice to itself or the industry at large unless provision is made for training a certain number of apprentices, both journeymen and technical men. The number to be trained depends on the ability of the organization to absorb them and give them rotational employment in every branch of the electrical department work from oiling motors to winding coils. After the prescribed course is completed their grasp of electrical work will be sufficiently broad to make it possible to assign them to work in the various branches of the department in accordance with their abilities and inclinations.

Proper training of the technical apprentices—engineering graduates entering the industrial field—needs far more intelligent study by the management than has been given in the past if the full measure of the intrinsic worth of the young engineer is to be obtained. These engineers are by training especially adapted for the many studies which must be made in an industrial plant into the usefulness of both new and old equipment. The technical apprentice enters willingly into these investigations, but if he is not thoroughly schooled in the various branches of the journeyman's work as well as drilled in the fundamentals of the sciences, he will not be fully able to judge the true scale of values of equipment which must deliver its output practically as well as in a theoretically efficient manner.

The publication you read in an hour may have taken months to prepare

Editorial excellence is not acquired accidentally. Helpful articles are not the result of chance. Ability to give an industry the character of reading matter best suited to its needs is not brought about by the waving of a magic wand (or its latter-day successor, the fountain-pen).

Thought, work, study, work, traveling, work, planning and work are required to do a publication justice—principally work, for the preparation and publishing of Electrical Review and Industrial Engineer is as big a job as the most time-consuming task which confronts you in your mill or shop. The publishers would rather have you consider the publication as a co-worker in your every day routine than to have to look upon it as so much "writing"—regardless of the value you might place upon the latter.

Like inside information? Then listen to this:

The January issue of the Electrical Review and Industrial Engineer required extensive traveling on the part of the staff. And a carefully picked staff it is, made up of men who were selected because they have demonstrated their fitness on four different publications. The traveling was occasioned by the desire to meet the men in the industry seemingly best qualified to supply the information for articles that will be useful in everyday work. There were plants to be visited and problems in operation and maintenance to be studied. This could not be done in an Editorial sanctum.

Similar investigation made the February issue possible. Meanwhile the staff has been increased by the addition of another well known associate editor, to permit of more traveling, more work, more study, more planning and more thinking. The first two issues of Electrical Review and Industrial Engineer have been uniformly good, we are told, by hundreds of readers. That standard will not only be maintained but improved.

These are a few thoughts which may be of passing interest as you turn the pages of this issue. It will take a comparatively short time to read it through—advertising pages as well —yes, a mere fraction of the time it took to prepare it.